UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT No. 22

IROQUOIS COUNTY SOILS

By J. G. MOSIER, S. V. HOLT, E. VAN ALSTINE
AND H. J. SNIDER
PREPARED FOR PUBLICATION BY L. H. SMITH

URBANA, ILLINOIS, JANUARY, 1922

IN RECOGNITION

The Soil Survey of Illinois was organized under the supervision of the late Dr. Cyril G. Hopkins. The work progressed for eighteen years under his guidance and the first eighteen soil reports bear his name as senior author. On October 6, 1919, Dr. Hopkins died in a foreign land in the service of the American Red Cross. It is the purpose to carry on to completion this great work of the Illinois Soil Survey in the spirit, and along the same general plan and lines of procedure, in which it was begun.

INTRODUCTORY NOTE

It is a matter of common observation that soils vary tremendously in their productive power, depending upon their physical condition, their chemical composition, and their biological activities. For any comprehensive plan of soil improvement looking toward the permanent maintenance of our agricultural lands, a definite knowledge of the various existing kinds or types of soil is a first essential. It is the purpose of a soil survey to classify the various kinds of soil of a given area in such a manner as to permit definite characterization for description and for mapping. With the information that such a survey affords, every farmer or land owner of the surveyed area has at hand the basis for a rational system of improvement of his land. At the same time the Experiment Station is furnished an inventory of the soils of the state, upon which intelligently to base plans for those fundamental investigations so necessary for solving the problems of practical soil improvement.

This county soil report is one of a series reporting the results of the soil survey which, when completed, will cover the state of Illinois. Each county report is intended to be as nearly complete in itself as it is practicable to make it, even at the expense of some repetition. There is presented in the form of an Appendix a general discussion of the important principles of soil fertility, in order to help the farmer and land owner to understand the significance of the data furnished by the soil survey and to make intelligent application of the same in the maintenance and improvement of the land. In many cases it will be of advantage to study the Appendix in advance of the soil report proper.

Data from experiment fields representing the more extensive types of soil, and furnishing valuable information regarding effective practices in soil management, are embodied in form of a Supplement. This Supplement should be referred to in connection with the descriptions of the respective soil types found in the body of the report.

CONTENTS OF SOIL REPORT No. 22

IROQUOIS COUNTY SOILS

APPENDIX

SUPPLEMENT

IROQUOIS COUNTY SOILS

By J. G. MOSIER, S. V. HOLT, E. VAN ALSTINE, AND H. J. SNIDER

PREPARED FOR PUBLICATION BY L. H. SMITH[1]

FORMATION

Iroquois county is situated on the eastern border of Illinois about one hundred miles south of the north line. The county measures approximately thirty-three by thirty-four miles, and comprizes an area of 1,123.62 square miles.

The most important period in the geological history of the county from the standpoint of soil formation was that during which the material that later formed the soils was being deposited. This was the Glacial period. At that time snow and ice accumulated in the region of Labrador, west of Hudson Bay, and in the Rocky Mountains to such an amount that the mass pushed outward from these centers, especially southward, until a point was reached where the ice melted as rapidly as it advanced. As the ice advanced in these movements it buried everything, even the highest mountains, in its path. It would then recede slowly, and apparently normal conditions would be restored for a long period, after which another advance would occur. At least six of these great ice movements took place, each of which covered some part of northern United States, altho the same parts were not covered every time.

In advancing from these distant northern centers of accumulation, the ice gathered up all sorts and sizes of material, including clay, silt, sand, gravel, boulders, and even large masses of rock. Some of these materials were carried several hundred miles, and the coarser masses rubbed against the surface rocks or against each other until largely ground into rock powder, which now constitutes much of the soil. As the ice melted upon reaching the limit of advance, the material was dropped. If the glacier remained in the same position for some time, this material accumulated in a broad undulating ridge called a lateral moraine if formed at the side of the glacier, or a terminal moraine if formed at the end. When the ice melted more rapidly than the glacier advanced, the terminus of the glacier receded and the material was deposited somewhat irregularly over the land, back of the moraines. This formation is known as a ground moraine. A glacier would often advance again, but not so far as before; or it would remain stationary, and another moraine would be built up. These moraines, or ridges, have a steep outward slope and a very gradual inward slope.

A pressure of forty pounds per square inch is exerted by a mass of ice one hundred feet thick, and these ice sheets may have been hundreds or even thousands of feet in thickness. The materials carried along in the ice, especially the boulders and pebbles, became powerful agents for grinding and wearing away the surface over which the ice passed. Preglacial ridges and hills were rubbed

[1] J. G. Mosier, in charge of soil survey mapping; S. V. Holt, in charge of field party; E. Van Alstine, in charge of soil analysis; H. J. Snider, in charge of experiment fields; L. H. Smith, in charge of publications.

down, valleys were filled with the debris, and the surface features were changed entirely. The mixture of materials deposited by the glacier is known as boulder clay, till, glacial drift, or simply drift.

THE GLACIATIONS OF IROQUOIS COUNTY

There were at least four ice advances that reached Iroquois county and covered it wholly or in part. The first advance that reached this county was probably the Illinoisan glacier, which covered all of Illinois except the northwest corner (practically all of Jo Daviess county), the southern part of Calhoun county, and the seven southernmost counties. (See state map in Bulletin 123 or 193). This glacier melted and somewhat normal conditions were restored, as is indicated by the thick soil formed from the material deposited by the glacier.

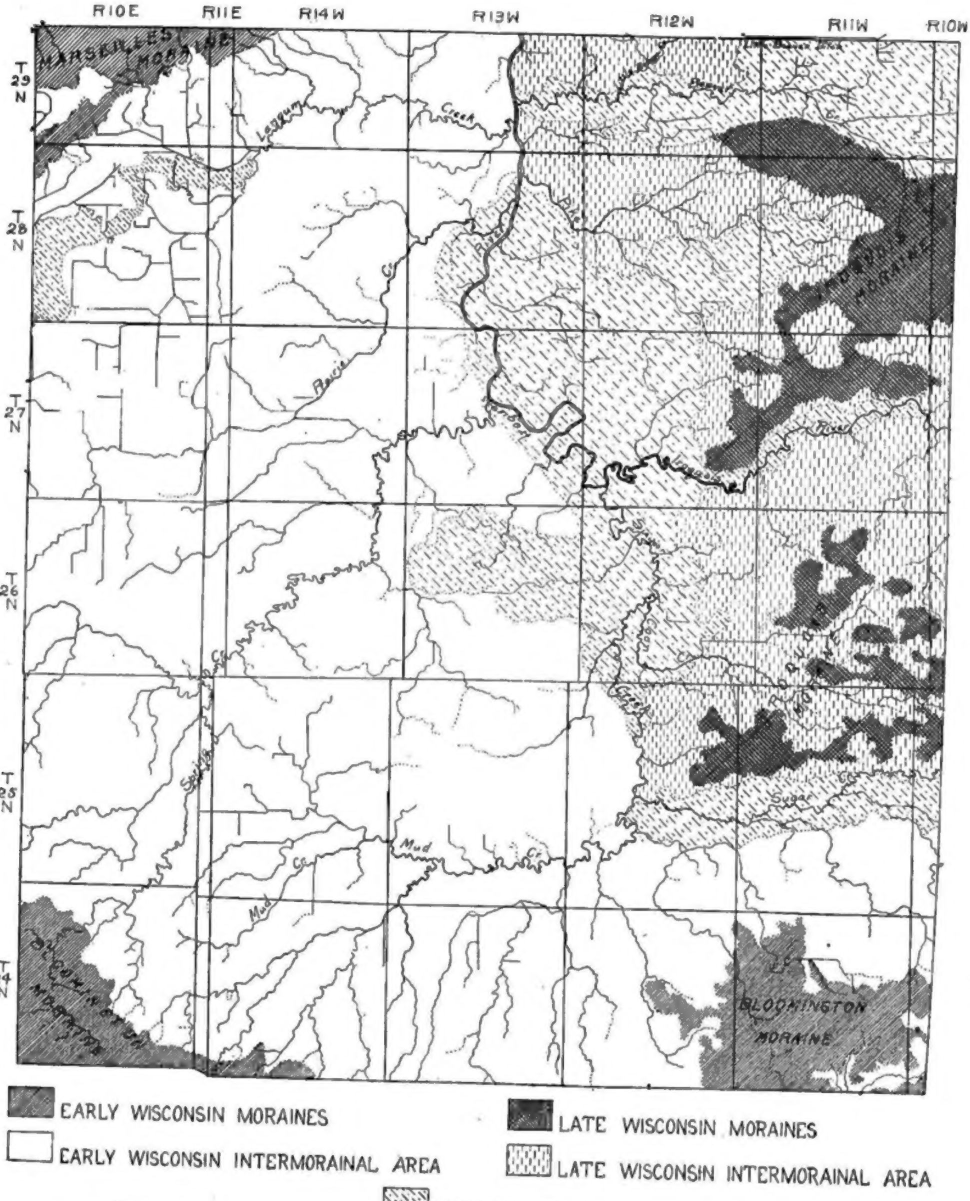
The drift left by this ice sheet was buried by another glacier, probably the Iowan; and this was followed by a third, known as the early Wisconsin. The material deposited by the early Wisconsin glacier forms most of the surface material west of the Iroquois river and south of Sugar creek. The moraine appearing in the southeastern and southwestern parts of Iroquois and bending down into the northern part of Vermilion county is known as the Bloomington moraine. Another moraine was built up by the early Wisconsin glacier along the northern boundary of Kankakee county and west of the Iroquois river. This is known as the Marseilles moraine.

The late Wisconsin glacier covered most of the county east of the Iroquois river and north of Sugar creek. A more or less distinct moraine found here is called the Iroquois moraine. This moraine is quite characteristically developed near Beaverville in the northeastern part of the county.

PHYSIOGRAPHY AND DRAINAGE

The county varies in topography from flat to slightly rolling. Even along the streams hills do not exist to any extent. The principal variations are due to the irregular deposition of glacial material, the depth of which varies from a few feet to more than three hundred feet, and averages probably about one hundred and fifty feet. The moraines take the form of irregular billowy ridges, and they vary in width from a mile or two, to six or eight miles. A broad flat valley, comprizing a large part of the intermorainal area, lies between the three moraines. This valley was formerly very poorly drained. It contained extensive swamps and many ponds, which usually became dry during the summer. The marginal ridges, with the underlying sands and gravels of this valley or basin, have brought about conditions that give rise to artesian wells. Water is obtained at depths varying from 30 to 160 feet.

With the exception of a few small areas in the northwest part, the entire county is drained by the Iroquois river and its tributaries, the principal of which are the Langum, Prairie, and Spring creeks from the west, with Sugar, Pike, and Beaver from the east. These streams, together with the dredge ditches which have been made, now provide a very good system of drainage. Erosion topography is limited to the immediate vicinity of the streams. In some places the subsoil becomes too heavy and tight for good drainage.



MAP SHOWING THE DRAINAGE BASINS OF IROQUOIS COUNTY WITH MORAINAL, INTERMORAINAL, AND TERRACE AREAS

The altitudes of several places in Iroquois county are as follows: Ashkum, 670 feet above sea level; Buckley, 702; Chebanse, 674; Cissna Park, 684; Cissna Junction, 690; Claytonville, 665; Clifton, 672; Crescent City, 637; Danforth, 658; Donovan, 670; Del Ray, 669; Fountain Creek, 677; Gilman, 654; Goodwine, 660; Hickman, 677; Iroquois, 673; Loda, 780; LaHogue, 664; Martinton, 627; Milford, 666; Onarga, 676; Papineau, 630; Pittwood, 643; Sheldon, 688; Stockland, 695; Thawville, 696; Watseka, 634; Woodland, 640; Wellington, 698.

During the Glacial period, the drainage of the Great Lakes to the north and east was blocked by the ice, and the water necessarily found an outlet to the south thru the Illinois and Wabash rivers. The former drained Lake Michigan and Lake Huron in part, while the latter drained Lake Erie. At that time the basins of the Iroquois and Kankakee were temporary broad lakes. That of the Iroquois extended from Onarga to the Marseilles moraine and westward across Ford county into Livingston county, and it probably overflowed into the Vermilion river and thence to the Illinois river. These lakes were shallow and did not exist for any great length of time. They were succeeded by swamps that have been only recently drained.

SOIL MATERIAL AND SOIL TYPES

The glaciers that covered Iroquois county left a deposit called till, glacial drift, or boulder clay (a mixture of boulders, gravel, sand, silt, and clay), having an average thickness of about 150 feet. This deposit, however, does not form the soil material except in small areas. The rock flour produced by the grinding action of the glaciers was reworked by the wind and deposited over practically all of the county to a depth of 12 to 40 inches. This loessial, or wind-blown material now covering the level and less rolling areas, has been transformed into soil by weathering and by the accumulation of organic matter. There is little doubt but that this wind-blown material was at one time fairly uniformly deposited over the exposed surface, but it has subsequently been removed in places by erosion, so that the boulder clay is exposed on some of the more rolling areas. The deposit is thicker on the early Wisconsin glaciation than on the late Wisconsin, because of a deeper original deposit (3 to 6 feet) and because there has not been so much erosion on this less rolling area.

During the melting of the glacier the streams draining this area were frequently flooded and carried large amounts of rather coarse material, such as gravel and sand. This was deposited in the valleys, partly filling them. Later the streams cut down thru the fill, leaving gravel terraces. This gravel was later covered with the fine material that now constitutes the soil. These terraces occur principally along Sugar creek, and in broad irregular expansions along the Iroquois river and to the northeast part of the county along Beaver creek. Part of this area, constituting the expansion south of Martinton, was produced by the breaking of the water over the moraine south and east of Hooper. Much sand was deposited by this overflow and this area south of Martinton contains many sand dunes.

The soils of Iroquois county are divided into the following groups:

(a) Upland Prairie Soils, including the upland soils that have not been covered with forests and on which the luxuriant growth of prairie grasses has produced relatively large amounts of organic matter.

(b). Upland Timber Soils, including nearly all the upland areas that are now, or were formerly, covered with forests.

(c) Terrace Soils, including bench lands, or second bottom lands, formed by deposits from overloaded streams, or by broad sheets of water arising from the melting of the glaciers.

(*d*) *Swamp and Bottom-Land Soils,* including the overflow lands or flood plains along streams, the swamps, and the poorly drained lowlands.

Table 1 gives a list of the types of soil found in Iroquois county, the area of each type in square miles and in acres, and its percentage of the total area. For example, it may be noted that the brown silt loam of the prairie occupies sixty percent of the area of the county. The accompanying map shows the location and boundary of each type of soil, even down to areas of a few acres.

For explanations concerning the classification of soils and the interpretation of the map and tables, the reader is referred to the first part of the Appendix to this report.

TABLE 1.—SOIL TYPES OF IROQUOIS COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	(a) Upland Prairie Soils (900, 1000, 1100, 1200)			
-26	Brown silt loam	681.81	436,358	60.68
-20	Black clay loam	80.46	51,494	7.16
-60	Brown sandy loam	106.37	68,077	9.45
-81	Dune sand	4.65	2,976	.41
-28	Brown-gray silt loam on tight clay	1.33	851	.12
-28.1	Brown silt loam on tight clay	7.36	4,710	.66
		881.98	564,466	78.48
	(b) Upland Timber Soils (900, 1000, 1100, 1200)			
-34	Yellow-gray silt loam	16.74	10,714	1.49
-64	Yellow-gray sandy loam	4.48	2,867	.40
-35	Yellow silt loam	1.58	1,011	.14
-38	Yellow-gray silt loam on tight clay	1.60	1,024	.14
		24.40	15,616	2.17
	(c) Terrace Soils (1500)			
-60	Brown sandy loam	108.30	69,312	9.64
-26	Brown silt loam	2.66	1,702	.24
-27	Brown silt loam over gravel	13.20	8,448	1.18
-64	Yellow-gray sandy loam	9.14	5,850	.81
-81	Dune sand	18.50	11,840	1.65
-34	Yellow-gray silt loam	.46	294	.04
-36	Yellow-gray silt loam over gravel	6.37	4,077	.57
-66	Brown sandy loam over gravel	4.98	3,187	.44
-67	Yellow-gray sandy loam over gravel	3.30	2,112	.29
-26.4	Brown silt loam on gravel	.33	211	.03
-20	Black clay loam	.25	160	.02
		167.49	107,193	14.91
	(d) Swamp and Bottom-Land Soils (1400)			
-26	Deep brown silt loam	29.06	18,599	2.59
-54	Mixed loam	3.88	2,483	.35
-61	Black sandy loam	12.61	8,071	1.12
-10.2	Peaty loam on sand	.45	288	.04
-01	Deep peat	1.78	1,139	.16
-02	Medium peat on clay	.73	467	.07
-13	Clayey muck	.25	160	.02
		48.76	31,207	4.35
	Water	.99	634	.09
	Total	1,123.62	719,116	100.00

INVOICE OF PLANT FOOD IN IROQUOIS COUNTY SOILS

SOIL ANALYSIS

The composition reported in the accompanying tables is, for the more extensive types, the average of several analyses. These analyses, like most things in nature, show more or less variation, but for general purposes they may be considered sufficient to characterize the soil type.

The chemical analysis of a soil, obtained by the methods here employed, gives the invoice of the total stock of the several plant-food materials actually present in the soil strata sampled and analyzed, but it should be understood that the rate of liberation, as explained in the Appendix (page 35), is governed by many factors.

THE SURFACE SOIL

In Table 2 are reported the amount of organic carbon (the best measure of the organic matter), and the total quantities of nitrogen, phosphorus, sulfur, potassium, magnesium, and calcium contained in 2 million pounds of the surface soil (the plowed soil of an acre about 6⅔ inches deep) of each type in Iroquois county.

Because of the fact that soils often vary so extremely within the type with respect to the presence of limestone and acidity, no attempt is made to include in the tabulated results figures purporting to represent the average amounts of these substances present in the respective types. Such averages cannot give the farmer the specific information he needs regarding the lime requirements of a given field. Fortunately, however, very simple tests which can be made at home will furnish this important information, and these tests are described on page 37 of the Appendix.

The variation among the different types of soil with respect to the content of important plant-food elements is very marked. For example, the deep peat contains, in the plowed soil of an acre, more than thirty times as much nitrogen as does the dune sand. Comparing the deep peat with the most common type in the county, we find about five times as much nitrogen in it as in the brown silt loam, while on the other hand the brown silt loam contains more than eight times as much potassium as is found in the deep peat. The supply of phosphorus in the surface soil varies from 660 pounds per acre in the dune sand to 1,450 pounds in the deep brown silt loam. A sulfur content of 190 pounds per acre is found in the dune sand, while in the deep peat there are 4,310 pounds of this element. The magnesium varies in the different types from 2,900 to 18,280 pounds, and the calcium content ranges from 5,700 to 24,840 pounds per acre.

It is important to note that some of the plant-food elements are present in very limited quantities as compared with crop requirements. Some simple computations are of interest in this connection. Assume, for example, that a four-field crop rotation of wheat, corn, oats, and clover yields 50 bushels of wheat per acre, 100 bushels of corn, 100 bushels of oats, and 4 tons of clover hay. It will be found that the most prevalent upland soil of Iroquois county, the brown silt loam, contains only enough total nitrogen in the plowed soil for the production of such yields to supply about ten rotations.

TABLE 2.—PLANT FOOD IN THE SOILS OF IROQUOIS COUNTY, ILLINOIS: SURFACE SOIL
Average pounds per acre in 2 million pounds of surface soil (about 0–6⅔ inches)

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	(a) Upland Prairie Soils (900, 1000, 1100, 1200)							
-26, 1526	Brown silt loam	65 020	5 300	1 060	920	39 700	10 590	10 670
-20	Black clay loam	65 260	6 160	1 310	1 030	42 260	16 600	19 450
-60	Brown sandy loam	57 880	4 700	1 270	990	23 900	6 390	24 840
-81, 1581	Dune sand	13 710	900	660	190	26 570	3 120	7 360
1128	Brown-gray silt loam on tight clay	44 180	3 840	1 060	760	32 320	7 060	8 260
1128.1	Brown silt loam on tight clay	46 860	4 240	860	460	39 900	9 620	10 020
	(b) Upland Timber Soils (900, 1000, 1100, 1200)							
-34	Yellow-gray silt loam	24 460	1 970	880	270	39 740	5 280	6 850
-64	Yellow-gray sandy loam	25 560	2 040	700	300	30 000	3 480	7 180
-35	Yellow silt loam	28 370	2 680	810	350	59 600	16 170	6 460
-38	Yellow-gray silt loam on tight clay	33 600	3 200	970	530	33 680	6 390	6 490
	(c) Terrace Soils (1500)							
-60	Brown sandy loam	55 770	4 880	1 170	990	23 610	5 020	16 970
-26, 926, 1026, 1126, 1226	Brown silt loam	65 020	5 300	1 060	920	39 700	10 590	10 670
-27	Brown silt loam over gravel	51 280	4 600	1 240	700	30 400	5 580	6 240
-64	Yellow-gray sandy loam	21 660	1 820	740	200	27 680	3 480	6 220
-81, 981, 1081, 1181, 1281	Dune sand	13 710	900	660	190	26 570	3 120	7 360
-34	Yellow-gray silt loam	34 620	3 040	1 040	400	46 420	9 580	8 560
-36	Yellow-gray silt loam over gravel	28 180	2 310	1 060	290	39 140	5 640	6 330
-66	Brown sandy loam over gravel	34 250	2 920	1 000	650	29 160	4 970	7 450
-67	Yellow-gray sandy loam over gravel	21 040	1 420	760	360	27 860	3 240	5 700
-26.4	Brown silt loam on gravel	35 720	2 880	1 080	380	28 240	5 280	6 000
-20	Black clay loam	57 980	5 220	1 380	760	34 760	14 440	17 320
	(d) Swamp and Bottom-Land Soils (1400)							
-26	Deep brown silt loam	70 060	5 860	1 450	1 320	46 770	18 280	22 280
-54	Mixed loam	77 040	6 700	1 280	1 800	28 620	6 800	9 060
-61	Black sandy loam	65 290	5 730	1 230	1 000	30 210	7 990	19 960
-10.2	Peaty loam on sand[1]	172 320	13 350	870	2 430	17 450	5 250	19 170
-01	Deep peat[2]	345 060	27 910	1 160	4 310	4 590	3 010	23 410
-02	Medium peat on clay[2]	211 120	16 040	730	2 990	8 600	2 900	18 660
-13	Clayey muck[1]	151 950	13 070	1 440	3 170	32 840	11 390	17 810

Limestone and Soil Acidity.—In connection with these tabulated data it should be explained that the figures on limestone content and soil acidity are omitted not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in general averages adequate information concerning the limestone requirement. The limestone requirement for soils is extremely variable. It may vary from farm to farm, and even from field to field. Therefore no attempt is made to include in these tables figures purporting to represent for the various types the limestone content or the soil acidity present. The need for limestone should be determined on every farm and for each field individually. Fortunately this can be easily done by the simple tests described in the Appendix to this report, page 37.

[1]Amounts reported are for 1½ million pounds of peaty loam and clayey muck.
[2]Amounts reported are for 1 million pounds of deep peat and medium peat.

TABLE 3.—PLANT FOOD IN THE SOILS OF IROQUOIS COUNTY, ILLINOIS: SUBSURFACE SOIL
Average pounds per acre in 4 million pounds of subsurface soil (about 6⅔-20 inches)

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	(a) Upland Prairie Soils (900, 1000, 1100, 1200)							
-26 1526	Brown silt loam............	60 530	5 280	1 430	1 080	84 710	28 420	18 920
-20	Black clay loam............	60 110	5 720	2 020	1 140	87 590	38 080	38 940
-60	Brown sandy loam..........	45 700	4 160	1 700	1 020	51 340	14 120	42 960
-81 1581	Dune sand................	14 860	960	1 100	320	52 480	6 000	13 420
1128	Brown-gray silt loam on tight clay................	49 240	4 280	1 440	760	76 280	19 520	13 520
1128.1	Brown silt loam on tight clay	47 200	4 640	1 200	480	84 200	25 080	15 080
	(b) Upland Timber Soils (900, 1000, 1100, 1200)							
-34	Yellow-gray silt loam.......	16 800	1 680	1 480	360	72 780	16 380	11 840
-64	Yellow-gray sandy loam.....	16 520	1 320	1 360	280	59 920	8 000	15 800
-35	Yellow silt loam............	24 440	3 380	1 760	580	139 300	70 560	65 140
-38	Yellow-gray silt loam on tight clay................	27 580	3 140	1 300	500	77 880	23 980	10 520
	(c) Terrace Soils (1500)							
-60	Brown sandy loam..........	41 940	3 710	1 550	850	51 250	11 050	25 270
-26 926 1026 1126 1226	Brown silt loam............	60 530	5 280	1 430	1 080	84 710	28 420	18 920
-27	Brown silt loam over gravel.	49 120	4 720	1 760	720	64 280	13 720	10 080
-64	Yellow-gray sandy loam.....	11 360	1 200	1 200	280	58 000	9 640	11 080
-81 981 1081 1181 1281	Dune sand................	14 860	960	1 100	320	52 480	6 000	13 420
-34	Yellow-gray silt loam.......	32 440	3 320	1 600	520	99 680	31 960	11 400
-36	Yellow-gray silt loam over gravel..................	18 980	2 180	1 620	240	84 660	18 740	10 520
-66	Brown sandy loam over gravel	36 680	3 400	1 490	730	60 280	11 590	13 210
-67	Yellow-gray sandy loam over gravel..................	13 240	1 040	1 360	600	62 800	9 080	10 160
-26.4	Brown silt loam on gravel...	38 160	3 400	1 600	480	59 680	11 640	9 840
-20	Black clay loam............	51 720	4 800	2 080	720	68 880	28 920	36 160
	(d) Swamp and Bottom-Land Soils (1400)							
-26	Deep brown silt loam.......	118 740	10 320	2 680	2 080	91 660	32 900	35 380
-54	Mixed loam................	33 280	3 080	1 040	600	62 280	11 680	13 960
-61	Black sandy loam..........	45 020	4 220	1 080	1 120	64 940	17 040	27 780
-10.2	Peaty loam on sand[1]........	149 670	9 450	1 230	2 460	41 640	12 000	36 120
-01	Deep peat[2]................	354 540	30 940	1 360	6 180	17 640	8 260	32 740
-02	Medium peat on clay[2]......	114 180	8 820	820	2 120	23 360	4 600	18 360
-13	Clayey muck[1]............	329 310	27 270	2 100	7 590	51 540	24 180	44 100

Limestone and Soil Acidity.—In connection with these tabulated data it should be explained that the figures on limestone content and soil acidity are omitted not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in general averages adequate information concerning the limestone requirement. The limestone requirement for soils is extremely variable. It may vary from farm to farm, and even from field to field. Therefore no attempt is made to include in these tables figures purporting to represent for the various types the limestone content or the soil acidity present. The need for limestone should be determined on every farm and for each field individually. Fortunately this can be easily done by the simple tests described in the Appendix to this report, page 37.

[1]Amounts reported are for 3 million pounds of peaty loam and clayey muck.
[2]Amounts reported are for 2 million pounds of deep peat and medium peat.

TABLE 4.—PLANT FOOD IN THE SOILS OF IROQUOIS COUNTY, ILLINOIS: SUBSOIL
Average pounds per acre in 6 million pounds of subsoil (about 20-40 inches)

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	(a) Upland Prairie Soils (900, 1000, 1100, 1200)							
-26 1526	Brown silt loam	29 150	3 300	2 020	1 180	147 660	86 810	107 680
-20	Black clay loam	26 590	3 600	2 780	3 180	129 590	83 100	167 860
-60	Brown sandy loam	24 690	3 360	1 860	840	87 420	23 970	42 150
-81 1581	Dune sand	13 290	1 020	1 620	360	80 220	9 690	20 730
1128	Brown-gray silt loam on tight clay	30 720	3 540	1 620	1 020	140 160	49 680	24 540
1128.1	Brown silt loam on tight clay	26 880	4 020	2 340	660	148 980	77 520	115 740
	(b) Upland Timber Soils (900, 1000, 1100, 1200)							
-34	Yellow-gray silt loam	12 360	1 800	2 070	300	116 970	35 610	20 670
-64	Yellow-gray sandy loam	11 760	1 020	1 800	300	85 260	14 400	21 300
-35	Yellow silt loam	24 900	3 600	2 370	840	183 990	127 680	203 880
-38	Yellow-gray silt loam on tight clay	21 750	3 690	2 100	930	142 230	61 500	22 800
	(c) Terrace Soils (1500)							
-60	Brown sandy loam	17 800	2 070	1 800	650	83 230	24 400	42 760
-26 926 1026 1126 1226	Brown silt loam	29 150	3 300	2 020	1 180	147 660	86 810	107 680
-27	Brown silt loam over gravel	23 400	2 760	2 280	1 020	93 900	28 080	20 400
-64	Yellow-gray sandy loam	15 720	2 220	1 800	240	114 720	31 200	18 360
-81 981 1081 1181 1281	Dune sand	13 290	1 020	1 620	360	80 220	9 690	20 730
-34	Yellow-gray silt loam	21 960	3 000	2 280	720	139 980	42 300	20 460
-36	Yellow-gray silt loam over gravel	15 060	2 250	1 890	240	119 970	32 310	20 160
-66	Brown sandy loam over gravel	22 920	2 580	1 840	580	99 760	24 560	24 200
-67	Yellow-gray sandy loam over gravel	13 320	1 920	2 220	240	105 300	22 860	15 840
-26.4	Brown silt loam on gravel	19 620	2 160	1 980	180	90 420	19 980	13 380
-20	Black clay loam	23 880	2 640	2 100	600	98 040	91 320	249 600
	(d) Swamp and Bottom-Land Soils (1400)							
-26	Deep brown silt loam	83 490	7 590	2 880	1 590	236 680	43 410	39 240
-54	Mixed loam	22 980	2 220	960	420	102 420	22 320	17 880
-61	Black sandy loam	16 710	2 250	1 950	960	100 920	32 580	41 670
-10.2	Peaty loam on sand	19 740	1 140	1 560	1 560	68 820	34 320	271 560
-01	Deep peat[1]	298 020	23 100	1 500	31 140	38 970	25 650	75 330
-02	Medium peat on clay	92 160	6 300	1 800	4 860	78 840	27 960	74 940
-13	Clayey muck	355 860	23 760	2 340	9 600	116 700	62 640	79 020

Limestone and Soil Acidity.—In connection with these tabulated data it should be explained that the figures on limestone content and soil acidity are omitted not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in general averages adequate information concerning the limestone requirement. The limestone requirement for soils is extremely variable. It may vary from farm to farm, and even from field to field. Therefore no attempt is made to include in these tables figures purporting to represent for the various types the limestone content or the soil acidity present. The need for limestone should be determined on every farm and for each field individually. Fortunately this can be easily done by the simple tests described in the Appendix to this report, page 37.

[1]Amounts reported are for 3 million pounds of deep peat.

With respect to phosphorus, the condition differs only in degree, this soil containing no more of that essential element than would be required for about thirteen crop rotations yielding at the rates suggested above. On the other hand the amount of potassium in the surface layer of this common soil type is sufficient for more than 31 centuries if only the grain is sold, or for more than 600 years if the total crops should be removed from the land and nothing returned.

These general statements relating to the total quantities of these plant-food materials in the plowed soil of the most prevalent type in the county certainly emphasize the fact that the supplies of some of these necessary elements of fertility are extremely limited when measured by the needs of large crop yields for even one or two generations of people.

THE SUBSURFACE AND SUBSOIL

In Tables 3 and 4 are recorded the amounts of plant food in the subsurface and the subsoil of the different types. It should be remembered, however, that these supplies are of little value unless the top soil is kept rich. These tables also show great stores of potassium in the prevailing types of soil but only limited amounts of nitrogen and phosphorus, in agreement with the data for the corresponding surface samples.

DESCRIPTION OF INDIVIDUAL SOIL TYPES

(a) UPLAND PRAIRIE SOILS

The upland prairie soils of Iroquois county cover 882 square miles, or 78.5 percent of the area of the county. They usually occupy the less eroded areas of the upland. They are black or brown in color, owing to their high organic-matter content. This land was originally covered with prairie grasses the partially decayed roots of which have been the source of the organic matter. The flat, poorly drained areas contain the greater amounts of organic matter, owing to the more luxuriant growth of the grasses there and to the excessive moisture in the soil which provided conditions better adapted for the preservation of their roots.

Brown Silt Loam (926, 1026, 1126, 1226)

Brown silt loam is the most extensive type in Iroquois county, some townships in the southern part being made up entirely of this type, while others are brown silt loam interspersed with a few very small areas of black clay loam. It covers an area of 681.81 square miles, or practically 60 percent of the area of the county. It is found on land which varies in topography from flat to slightly rolling. The more rolling phase is found in the northwest part of the county and on the moraines in the vicinity of Beaverville in the northeast part.

While this is primarily a prairie type, timber has recently invaded it to a slight extent in some localities. The trees found on the timbered brown silt loam are usually bur oak, wild cherry, black walnut, ash, and elm, but their occupation of the soil has not been sufficiently long to change its character to any great extent.

The surface soil, 0 to 6⅔ inches, is a brown silt loam varying from a yellowish brown on the more rolling areas to a dark brown or black on the more nearly level and poorly drained tracts. In physical composition it varies to some extent, but it normally contains from 55 to 75 percent of the different grades of silt. In the lower areas the proportion of clay is usually higher than on the more rolling parts, where a perceptible amount of sand may occur. With the flooding of a very large part of the county during the time of the melting of the glacier, more or less sand was carried in and deposited on some of the lower parts, altho much of this has received a deposit of fine silt and clay. Some of the sand was carried to the higher lands by the wind and became mixed with the soil, forming a sandy loam or a sandy phase of the silt loam.

The organic-matter content of the surface soil varies from about 4 to 6 percent, depending on topography, and averages about 5.3 percent, or 53 tons per acre. In small areas on the more rolling parts of the moraines erosion has occurred to such an extent that the type has been changed, but these areas are not large enough to map. In this county the organic-matter content is about the same in amount in the early and the late Wisconsin glaciations.

The natural subsurface is represented by a stratum which varies from 6 to 16 inches in thickness. This variation is due either to erosion, or to the fact that more shallow-rooting grasses usually grew on the higher and better-drained land, or to both of these causes. Erosion removed some of the surface soil from the steeper parts and deposited it on the lower land, thus leaving a thinner layer of the dark soil in one case and producing a thicker one in the other. The physical composition of the subsurface varies in somewhat the same manner as the surface. In some parts, especially on the moraines of the late Wisconsin glaciation, the glacial till constitutes part or all of the subsurface soil.

The organic-matter content is about the same in both glaciations, but varies with topography the same as the surface soil. The average is about 2.6 percent, or 52 tons per acre in a stratum twice the thickness of the surface soil. In color the subsurface varies from a yellowish brown to dark brown or almost black, always changing to a lighter color with increasing depth.

The natural subsoil begins at a depth of 12 to 22 inches and extends to an indefinite depth but is sampled from 20 to 40 inches. It varies from a yellow to a drabbish yellow, silty, clayey material, sometimes composed wholly or in part of boulder clay. This applies especially to the late Wisconsin glaciation. In the flat areas that are not subject to erosion, but where material has been washed in from the higher surrounding land, the subsoil to a depth of 40 inches may not reach the boulder clay.

In general, the three strata of this type are formed from either wind-blown loessial material, boulder clay, or from material deposited in shallow water. A phase of brown silt loam is found on the moraines in the county where, because of the removal of part of the fine loessial material, the glacial drift is encountered at less than 30 inches from the surface. If the drift is quite compact, as is occasionally the case, this gives rise to a subsoil that is somewhat inferior, owing to its less pervious character. This condition, however, does not occur very frequently nor does it include large areas, since most of the glacial drift is pervious and some is even gravelly.

Management.—Originally when the virgin brown silt loam was first cropped, it was in fine tilth, worked easily, and large crops could be grown with much less work than now. Continuous cropping to corn, or to corn and oats, with the burning of corn stalks, stubble, grass, and even straw in many cases, has in a great measure destroyed the tilth, so that now the soil is more difficult to work, washes rather badly, runs together, and bakes more readily than formerly. Unless the moisture conditions are very favorable, the ground will plow up cloddy, with the result that unless well-distributed rains follow, a good seed bed is difficult to produce. The clods may remain all season. Much plant food will be locked up in them, and the best results cannot be obtained. This condition of poor tilth may become serious if the present methods of management continue; in some cases it is already one of the factors that limits crop yields. The remedy is to use a rotation having a clover crop and to increase the organic-matter content by plowing under every available form of vegetable material, such as farm manure, corn stalks, straw, clover, stubble, and even weeds. Fresh organic matter is not only of great value in improving the physical condition of this type of soil, but it is equally important because of its nitrogen content, and also because of its power, as it decays, to liberate potassium from the inexhaustible supply in the soil, and phosphorus from the phosphate contained in or applied to the soil.

The deficiency of organic matter in the soil is shown by the way the fall-plowed land runs together during the winter, or at any time when heavy rains occur. Fall-plowed land should be disked early and deep for the purpose of conserving moisture, raising the temperature, and making plant food available.

For permanent, profitable systems of farming on brown silt loam, phosphorus should be applied liberally, and sufficient organic matter should be provided to furnish the necessary amount of nitrogen. On the ordinary phase of the type limestone is already becoming deficient in the upper strata altho it often exists in considerable quantity in the subsoil. For the permanent improvement of this soil an application of 2 tons of limestone and ½ ton of finely ground rock phosphate per acre about every four years should be made, with the return to the soil of all manure made in a rotation.

Suggestions for practical systems of cropping will be found in the discussion of crop rotations in the Appendix, on page 42. For the results of actual field experiments in improving the soil of the brown silt loam type the reader is referred to page 46 of the Supplement.

Black Clay Loam (920, 1120)

Black clay loam represents the flat prairie land that was formerly swampy. It is sometimes called "gumbo" because of its sticky character. Its occurrence in the flat poorly drained areas is due to the accumulation of organic matter and to the washing in of clay and fine silt from the higher adjoining areas. Aside from a large body of this type found in the northwest part of the county, black clay loam occurs mainly in the south-central part, scattered about in small areas. This type occupies 80.46 square miles, or 7.16 percent of the area of the county.

The surface soil, 0 to 6⅔ inches, is a black, plastic, granular, clay loam varying locally to a black clayey silt loam, or even to a black sandy clay loam. In physical composition, it varies somewhat as it grades into other types. Often it contains a perceptible amount of sand, and even gravel may be present. In some places that were formerly sloughs the water has deposited gravel in sufficient abundance to form a gravelly black clay loam. The organic-matter content varies from 4.7 to 6.4 percent, with an average of 5.5 percent, or 55 tons per acre.

The natural subsurface stratum has a thickness of 10 to 16 inches. It varies from a black to a brownish drab clay loam and is usually somewhat heavier than the surface soil. It grades into a dull yellow or a drabbish or olive-colored material with depth. The average organic-matter content of the stratum sampled (6⅔ to 20 inches) is about 2.4 percent, or 48 tons per acre. The stratum is usually rather pervious to water, owing to jointing or checking from shrinkage in times of drouth, to the penetration of plant roots, and to the action of crayfish and other animals. Some exceptions to this are found where it grades toward brown-gray silt loam on tight clay (1128) and brown silt loam on tight clay (1128.1). Here the lower strata become somewhat impervious and drainage is slow. These areas occur principally west of the Iroquois river in Townships 27 and 28 North.

The subsoil to a depth of 40 inches varies in composition from a clayey silt to a very heavy clay, and in color from a dull drabbish yellow to drab or olive. Because of poor natural drainage, the iron in the subsoil is not highly oxidized. Concretions of lime carbonate are frequently found. The perviousness of the subsoil is about the same as that of the subsurface and is due to the same causes. When thrown out on the surface where wetting and drying may take place, it soon breaks into small irregular masses about one-fourth to one-half inch square.

The black clay loam presents many variations. It may change with a difference of only a foot or two in elevation. In this county, as elsewhere, the boundary lines between the black clay loam and the brown silt loam are not always distinct. Sometimes on the border between these two types the subsoil is distinctly that of black clay loam, while the surface soil is very silty, or is a good brown silt loam. The washing in of silty material from the surrounding higher lands, especially near the edges of the areas, modifies the character of the soil, giving it a brown silt loam surface. With the annual cultivation of the soil this change is taking place more rapidly now than formerly when washing was largely prevented by prairie grasses. Many small areas of black clay loam in the more rolling parts are being slowly buried by this process.

The areas of heavier subsoil are found in Townships 27 and 28 North, Ranges 10 and 11 East, and 13 and 14 West. This constitutes an old lake floor which was covered with a deposit of very fine material.

Management.—Drainage is the first requirement in the management of this type and, if the outlet is obtainable, this may usually be accomplished with little difficulty. An exception is found west of the Iroquois river in parts of Townships 27 and 28, where drainage is prevented by tight clay subsoil. Thoro drainage helps to keep the soil in good physical condition and is very necessary. After the organic matter is necessarily destroyed by the process of nitrification,

and after the limestone is removed by cropping and leaching, the physical condition of the soil becomes poorer, and as a consequence more difficult to work. Both organic matter and limestone tend to develop granulation and mellowness, which are very essential with heavy soils. The organic matter should be maintained by turning under manure and such crop residues as corn stalks and straw, and by the use of clover and pasture in rotations.

The use of limestone will probably be of little or no value on most of this soil because the subsoil and subsurface are usually naturally charged with carbonates. Because of possible exceptions to this condition, however, it is recommended that the test for the presence of carbonates described in the Appendix, page 37, be made; and if carbonates are not found within a foot of the surface, a moderate application of limestone, say 2 tons per acre, should be made.

For building up this type of soil to its highest state of fertility the phosphorus content ought to be increased. This may be well accomplished by the use of rock phosphate applied at the rate of one-half ton per acre once during each crop rotation.

While the black clay loam is one of the most productive soils in the state, yet its high content of clay and humus imparts a tendency to shrink and expand to such a degree as to be objectionable at times, especially during drouth. The clay and humus expand when the soil is wet, and shrink when the moisture evaporates or is used by the growing crop. This results in the formation of cracks, which are sometimes as much as two or more inches in width at the surface and extend with lessening width to two or three feet in depth. These cracks allow the soil to dry out more rapidly, and as a result the crop is injured thru lack of moisture. They do much damage by "blocking out" hills of corn and severing the roots. While cracking may not be prevented entirely, good tilth with a soil mulch will do much toward that end.

Cultivation is more essential on this type, both for aeration and for the conservation of moisture, than on almost any other type in the county. It must be remembered, however, that cultivation should be as shallow as possible in order to prevent injury to the roots of corn. (See Bulletin 181.)

Occasional small patches of alkali soil are found in areas of black clay loam. These spots are indicated by the fact that oats lodge badly and corn makes a poor growth, usually turning yellow or brown. If the amount of alkali is large, the corn may not grow to a height of more than two or three feet and will have a bushy appearance. Even if it reaches almost normal height, it does not produce much grain. The fragments of shells that are frequently found are indications of alkali.

The results of field experiments on black clay loam are given on page 54 of the Supplement.

Brown Sandy Loam (960, 1060, 1160, 1260)

The brown sandy loam of the upland is confined very largely to the northern three-fifths of the county. The southern two tiers of townships contain comparatively small areas, the largest being in the east part along Mud and Sugar creeks. Much the larger area is found in the northeast part of the county north

of Woodland Junction. A low, broad ridge of sandy loam that probably represents the southern shore line of the old lake extends east and west thru Onarga. Another area is found below the Marseilles moraine in the northwest part of the county. This type is very irregularly distributed, being mixed with the brown silt loam, into which it grades. It covers altogether an area of 106.37 square miles, or about 9.5 percent of the area of the county. Its formation is due either to overflow by glacial drainage or to the action of the wind in carrying the sand from the overflow regions to the higher ones. It varies in topography from slightly rolling to flat.

The surface soil, 0 to 6⅔ inches, is a brown sandy loam varying in color from a light brown to a black and in physical composition from a loam with about 50 percent of sand to a very sandy loam carrying 75 percent, or slightly more, of sand. Many small areas of sand are found in this type but they are too small to be shown separately on the map. A representative sample would contain from 60 to 65 percent of sand, mostly of medium grade. The organic-matter content varies from 4.5 to 5.2 percent with an average of 5 percent, or 50 tons per acre.

The natural subsurface stratum varies in thickness from 7 to 12 inches, and in color from dark brown to brownish yellow, usually passing into a yellow sandy silt or silty sand in the lower part of the stratum. In physical composition it varies even more than the surface layer. The organic-matter content of the stratum sampled (6⅔ to 20 inches) is about 2 percent, or 40 tons per acre in four million pounds.

The subsoil varies both in color and in physical composition. The color may be a bright yellow under conditions of good drainage, or a drabbish yellow where the water table has been rather high. In composition, it may be sand, silt, or clayey silt. As a general rule, the subsoil of the poorly drained areas is heavier than that of the higher and more rolling parts. In some cases the subsoil of the more rolling land may be formed from boulder clay.

Management.—This type in many places needs drainage and, because of the pervious character of the subsoil, this is easily accomplished by tiling. For a sandy loam, the soil is reasonably well supplied with all elements of plant food. Where carbonates are absent, limestone should be used liberally; applications of 2 to 3 tons per acre should be made. A rotation including legumes should be practiced and organic residues should be returned to the soil. Where this is done, sufficient phosphorus and potassium are likely to be liberated for satisfactory results for many years to come, altho ultimately one or both of these elements may need to be supplied—phosphorus first on the more compact phase, and potassium first on the more sandy areas.

Alkali patches occur in considerable numbers, especially on the lower areas which contain the highest percentage of organic matter. The growth of sweet clover is recommended for these areas. One to two hundred pounds per acre of potassium salts may be applied on these alkali spots with good results.

Dune Sand (1081, 1181)

The upland dune sand covers an area of 2,976 acres. Its origin is due almost entirely to the blowing of sand from lower, sandy areas to the upland. The type

occurs principally in a few isolated areas where sandy loam prevails. In topography it varies from flat to rolling with many rounding elevations 20 to 40 feet high.

The surface soil, 0 to 6⅔ inches, varies from a yellow sand to a brownish yellow loamy sand, composed largely of material of medium grade. The soil is low in organic matter, having an average of only about 1.2 percent, or 12 tons per acre in the plowed soil.

The subsurface consists of yellow sand, with about .6 percent of organic matter.

The subsoil is much the same as the subsurface except that its organic-matter content is slightly lower.

Management.—The upland sand dunes should be treated in the same way as those of the terrace (see page 22). These dunes have usually been covered with scattering oak trees, chiefly *Quercus marylandica.*

Brown-Gray Silt Loam on Tight Clay (1128)

Brown-gray silt loam on tight clay occurs almost entirely in Townships 27 and 28 North, Ranges 13 and 14 West. None is found east of the Iroquois river, at least not in areas sufficiently large to be shown on the map. This type is flat in topography, having been formed by deposition from the waters of a shallow lake. A considerable degree of acidity has developed, and this may have aided in the formation of this peculiar type. The area covered by this type is 851 acres.

The surface soil, 0 to 6⅔ inches, is a brown silt loam, but it develops a grayish tint when it becomes dry after a rain. The color of the surface, however, is not uniform; there may be patches of different shades of gray mixed in with the darker soil, giving it a mottled appearance somewhat similar to the scalds of southern Illinois. The organic-matter content is about 3.8 percent, or 38 tons per acre.

The natural subsurface consists of a layer from 7 to 10 inches in thickness which varies from a brown silt loam to a grayish silt or a clayey silt. The upper part of the subsurface is about the same color as the surface soil, or it may be lighter. This is underlain by a grayish stratum varying from 2 to 8 inches in thickness, which is followed by a heavy subsoil.

The subsoil stratum is a heavy, plastic, impervious, yellowish clay that extends to a depth of several feet. It is sometimes underlain by a stratum of sand, but this is so deep that it has little or no effect on drainage.

Management.—Altho this type needs drainage very badly, it is difficult to drain because of the level topography and the impervious subsoil. According to the samples analyzed it is also acid and will require limestone to correct the acidity and to put it into condition for growing clovers to the best advantage. About 2 to 4 tons of limestone per acre is recommended. The phosphorus content is about the same as that of the brown silt loam, and for permanent improvement this element should be supplied. In the management of this soil one very important consideration is the increasing of the organic-matter content. To do this, all forms of crop residues should be turned under, as well as legume crops. Deep-rooting crops should be grown to open up the subsoil.

Brown Silt Loam on Tight Clay (1128.1)

Brown silt loam on tight clay occurs in the same region as brown-gray silt loam on tight clay, but is a slightly better soil because of the absence of the gray stratum in the subsurface and the presence of a more pervious subsoil. This type covers an area of 4,710 acres.

The surface soil, 0 to 6⅔ inches, is a brown silt loam which shows a grayish tint after becoming dry. The color, however, is not uniform, being lighter in some parts than in others. This gives a field the same mottled appearance that is seen in the preceding type. The stratum contains about 4 percent of organic matter, or 40 tons per acre.

The subsurface consists of a brown silt loam which passes into a heavy brownish clayey material at 12 to 15 inches in depth. The stratum sampled (6⅔ to 20 inches) has about 2 percent of organic matter, or 40 tons per acre.

The subsoil consists of a yellowish or drabbish yellow clay, very plastic and tough. It is rather impervious, with the result that drainage does not take place very readily.

Management.—Because the type is usually lacking in limestone in the upper strata, an application of 2 tons per acre of this material is recommended. Drainage is very difficult because of the tight subsoil, and in order to drain it well the lines of tile must necessarily be placed much closer than in the brown silt loam (1126). The requirement as to organic matter is the same as for the preceding type. Deep-rooting crops such as sweet clover will be of great benefit.

(b) UPLAND TIMBER SOILS

The upland timber soils include nearly all the upland areas that are now, or have been, covered with forests. These soils contain much less organic matter than those of the prairie because of the difference in the vegetation that covered them. In forests the vegetable material from trees accumulates upon the surface and is either burned or suffers almost complete decay. Grasses, which furnish large amounts of humus-forming roots, do not grow to any extent because of the shade. Moreover, the organic matter that had accumulated before the timber began growing is removed thru various decomposition processes, with the result that in these soils generally the content of nitrogen and organic-matter has become too low for the best growth of farm crops.

The total area of upland timber soils in the county is 24.40 square miles, or 2.17 percent of the area of the county.

Yellow-Gray Silt Loam (934, 1034, 1134, 1234)

Yellow-gray silt loam is not very extensive in this county, altho it is distributed along most of the courses of the larger streams, where it forms a narrow belt on either side. The area covered by this type is 16.74 square miles, or about 10,000 acres. In topography, it is undulating to slightly rolling and usually has good surface drainage.

The surface soil, 0 to 6⅔ inches, is a gray or yellowish gray silt loam, incoherent and mealy but not granular. In physical composition it varies according to its relation to other types. Where it occurs in the sandy loam areas it

frequently becomes somewhat sandy, and very small areas may contain enough sand to be mapped as sandy loam. White oak and hickory are common trees on this type. The organic-matter content is about 2.1 percent, or 21 tons per acre. The amount increases where the type grades into the brown silt loam which usually borders it.

The natural subsurface stratum varies from 3 to 10 inches in thickness. In color it is gray, grayish yellow, or yellow. It is somewhat pulverulent, but becomes more coherent and plastic with increasing depth. The amount of organic matter of the stratum sampled (6⅔ to 20 inches) is about .7 percent.

The subsoil is a yellow or grayish yellow clayey silt or silty clay, somewhat plastic when wet but pervious to water. Sometimes the subsoil is made up wholly or in part of glacial material. The type as mapped includes some narrow, steep slopes along the bottom lands of streams, that are really yellow silt loam but are too narrow to be shown as such on the map.

Management.—In the management of yellow-gray silt loam, one of the most essential considerations is the maintenance or increase of organic matter. This is much more necessary with the yellow-gray silt loam than with the brown silt loam because of the fact that this soil is naturally much lower in organic matter, having only about two-fifths as much as the brown silt loam. The deficiency of organic matter causes the soil to run together, in the freezing and thawing of winter and in the wetting by the heavy rains of spring and summer. Organic matter will help to prevent washing on the more rolling areas. As it decays, it supplies nitrogen and at the same time tends to liberate other plant-food elements, as explained in the Appendix.

Since the soil is sometimes acid, it is often necessary to apply 2 or 3 tons per acre of ground limestone before the best results can be obtained with legumes. Later applications may be smaller. The growth of legumes is very essential since they furnish organic matter to turn back into the soil and at the same time supply the necessary nitrogen. But all forms of organic matter, such as corn stalks, manure, and weeds are of value and they should be turned into the soil rather than burned. An application of about ½ to 1 ton of rock phosphate per acre should be made about every four years, preferably when the legume or manure is turned under or else preceding the sowing of clover. For the results of field experiments on this type of soil the reader is referred to page 55 of the Supplement.

Yellow-Gray Sandy Loam (1164, 1264)

With only a few exceptions, the yellow-gray sandy loam occurs adjacent to the streams in a manner similar to the yellow-gray silt loam. The type is usually slightly rolling. It covers an area of 2,867 acres.

The surface soil, 0 to 6⅔ inches, is a gray to yellow-gray sandy loam containing about .75 percent of organic matter, or 7.5 tons per acre.

The subsurface is a sandy loam varying in color from yellow to grayish yellow. It contains almost as much organic matter as the surface soil.

The subsoil varies considerably, being made up in some places of a yellowish, sandy, clayey material, while in others it is composed of boulder clay, and in still others, of sand.

Management.—As a type, the yellow-gray sandy loam is somewhat inferior to most other soils of the county. It is low in practically all elements of fertility. In the samples examined carbonates were lacking even in the subsoil. Where such a condition exists 2 to 4 tons of limestone per acre should be applied so that legumes will grow well. The legumes should be turned under to increase the amount of nitrogen which is now much too low for a productive soil. All organic residues should be put back into the soil for the same purpose. The type is low in phosphorus, and ultimately this element must be supplied if the best results are to be obtained in the growth of crops. This element can be built up by the application of about ½ to 1 ton per acre of rock phosphate once in the rotation for two or three rotations, and thereafter a quantity sufficient to replace what is removed by crops.

Yellow Silt Loam (1135)

Yellow silt loam is found on steep slopes along the streams, and its origin is due to erosion. It covers an area of 1,011 acres.

The surface soil, 0 to 6⅔ inches, consists of a yellow to brownish yellow silt loam varying in composition from a sandy material on the one hand to a rather heavy phase on the other. The surface stratum contains about 2.4 percent of organic matter, or 24 tons per acre.

The subsurface is a yellow silty or sandy material varying toward a silty clay. The stratum contains about one percent of organic matter.

The subsoil is a yellow clayey silt and in many cases is formed from boulder clay.

The type is usually not under cultivation and can be used only for pasture.

Yellow-Gray Silt Loam on Tight Clay (1138)

Yellow-gray silt loam on tight clay occurs only in Township 27 North, Range 13 West. It covers only 1,024 acres.

The surface soil, 0 to 6⅔ inches, is a gray or yellowish gray silt loam containing about 2.9 percent of organic matter, or 29 tons per acre.

The subsurface is a grayish yellow silt loam passing into a heavy impervious stratum at about 15 to 17 inches. It contains 1.3 percent of organic matter or 26 tons per acre in four million pounds of soil.

The subsoil is a stiff, impervious clay, varying from yellow to drabbish yellow in color.

Management.—The greatest needs of this type are limestone and legume crops. The subsurface is usually quite acid, altho the subsoil in some places contains a small amount of limestone. Fortunately this very poor type of soil covers but a small area.

(c) TERRACE SOILS

The terrace soils of Iroquois county are formed in two ways: first, as gravel outwash plains from the melting glacier; and second, as gravel fills in stream valleys. The extensive areas along Beaver creek and in the vicinity of Pittwood, also south and east of Crescent, are of the former formation while those along

Sugar creek and the Iroquois river are of the latter. The depth to the gravel and sand varies to some extent, being from 24 inches to five feet or more. On account of the high water table resulting from the shallow cuts of streams the terrace types in this county are not easily drained.

The total area of all the terrace types in Iroquois county is 167.49 square miles, or nearly 15 percent of the area of the county.

Brown Sandy Loam (1560)

The brown sandy loam of the terrace, is one of the most common types in Iroquois county. It covers 108.30 square miles, or nearly 10 percent of the area of the county. It does not differ very much in composition from the upland sandy loam.

The surface soil, 0 to 6⅔ inches, is a brown sandy loam varying in color from black to light brown, and in composition from a loam to a sand. A representative sample, however, will contain about 65 to 70 percent of sand. The organic-matter content varies from 3 to 8 percent, with an average of about 5.1 percent, which is equivalent to 51 tons per acre.

The natural subsurface consists of a sandy loam layer varying in thickness from 6 to 12 inches and in color from black to brownish or yellowish. The organic-matter content of the stratum sampled (6⅔ to 20 inches) is about 1.7 percent, or 34 tons per acre.

The subsoil is a yellow to drabbish yellow clayey sand varying to a sandy clay, and is readily pervious to both air and water. Limestone is sometimes found in the subsoil.

Management.—The analysis of samples taken from different locations show great variation with respect to the limestone requirement. In some localities carbonates are abundant in all strata analysed, while in other places these are absent in all strata. In this situation, therefore, it is especially necessary to apply the tests for acidity and carbonates described on page 37 of the Appendix. If carbonates are not present within a foot of the surface, this fact may be taken as a sure indication that limestone is needed for the thrifty growth of legumes; it should be applied at the rate of 2 to 4 tons per acre. Phosphorus fertilizer is not so necessary on this kind of soil as on the brown silt loam, owing to the fact that on this type the roots of plants are distributed to a greater extent thru the soil and to a greater depth than in the brown silt loam. However, this element is becoming somewhat low and in some instances applications may be profitable, especially after the stock of nitrogen is well built up.

Brown Silt Loam (1526)

Brown silt loam occurs as rather isolated areas in the terraces and covers only 2.66 square miles, or 1,702 acres.

The surface soil, 0 to 6⅔ inches, contains approximately the same percentage of organic matter as the upland brown silt loam. In physical composition it varies to a considerable extent according to the surrounding soil types, and often grades into a sandy loam.

The natural subsurface is represented by a stratum 7 to 11 inches in thickness. It is a brown silt loam which changes to yellow with increasing depth.

The subsoil is a yellow sandy silt or sandy clay varying to a yellow sand. It is easily permeated by water and air.

Management.—The type requires the same treatment as the upland brown silt loam (see page 10).

Brown Silt Loam over Gravel (1527)

Brown silt loam over gravel is found principally along the streams and constitutes a part of the true stream terrace. It covers an area of 13.20 square miles, or 8,448 acres.

The surface soil, 0 to 6⅔ inches, is a little lighter in color than the upland brown silt loam. It varies somewhat in composition, being distinctly sandy in some places. It contains about 4.4 percent of organic matter, or 44 tons per acre.

The natural subsurface comprizes a silt loam stratum varying from 6 to 12 inches in thickness. It varies in color from brown to light brown. The stratum sampled (6⅔ to 20 inches) contains about 2.1 percent of organic matter, or 42 tons per acre.

The subsoil varies from a yellow silt to a yellow sandy silt. In some instances gravel is found at a depth of 36 to 48 inches. This provides good drainage where the water table is lowered sufficiently.

Management.—In the samples examined the lower strata of this type were acid. In cases where this is the condition, 2 or 3 tons of limestone per acre will be required as an initial application to correct the acidity and thus provide favorable conditions for the growth of legumes. About half the amount of this initial application should be applied every four years thereafter, or until the most favorable conditions for the growth of legumes are established. The same need for turning under legumes and organic residues exists in this type as in other brown silt loam types of the county.

Yellow-Gray Sandy Loam (1564)

Yellow-gray sandy loam is found very largely along the streams, altho an occasional small area may form an exception to this. It is associated with the yellow-gray silt loam in that it occurs in similar situations and that it has been covered by forests. The total area occupied by this type is 5,850 acres.

The surface soil, 0 to 6⅔ inches, is a brownish gray or brownish yellow sandy loam varying in physical composition in the same way as the other sandy loams of the county. The organic-matter content is about 2.5 percent, or 25 tons per acre.

The subsurface is a yellow sandy loam varying to a sandy silt loam and even to a sand. It contains about .5 percent of organic matter.

The subsoil consists of a yellow sandy silt that extends into gravel, in some instances at a depth of 36 to 40 inches. It contains about .45 percent of organic matter.

Management.—According to the samples tested this type is strongly acid, and an initial application of about 4 tons of limestone per acre should be made. This should be followed with about 2 tons every four years until the soil is brought into condition for the best growth of legumes. Organic matter, especially

legumes, must be turned under to bring about conditions of good tilth in the soil and to increase the supply of nitrogen, which analysis shows to be extremely low. The phosphorus content is likewise extremely low and ought to be built up before it becomes a limiting element.

Dune Sand (1581)

Dune sand on the terrace consists of rather small, irregular, isolated areas, all of them together covering 18.5 square miles, or 1.65 percent of the area of the county. These dunes have been formed of sand deposited as sand bars by the streams that once covered these regions. Later this sand was reworked by the wind, which piled it up into dunes ranging from a few feet to 25 or 30 feet in height.

The surface soil, 0 to 6⅔ inches, varies from a brownish yellow, slightly loamy sand to a yellow sand. It contains about 1.2 percent of organic matter, or 12 tons per acre. The sand is usually of medium texture and is comparatively free from the finer constituents.

The subsurface consists of a layer composed very largely of yellow sand, altho on the more loamy phases there may be enough organic matter to give the top of this stratum a brownish tint. It contains about .6 percent of organic matter.

The subsoil is a yellow sand with about .4 percent of organic matter.

Management.—This dune sand contains no limestone, either in the surface, subsurface, or subsoil, and it is exceedingly poor in nitrogen. Altho the total supply of potassium is large, this element is likely to be locked up to a considerable extent in sand grains and consequently is not susceptible of liberation by practical means altho sufficient amounts can usually be made available for very good crops. (On swamp sands and sandy loams long exposed to leaching, potassium is often the first limiting element, especially where a fair supply of humus exists, as in the so-called "black sand.")

The phosphorus content of sand soils is not high, but this element exists to a considerable extent in other constituents than sand grains. The United States Bureau of Soils separated two types of sandy soil—glacial sand and sandy loam—into coarse, medium, and fine particles, analyzed each grade for phosphorus, and found that as an average of the two soils the fine portion was eighteen times as rich in the element phosphorus as the coarse. Under successful cropping, such a limited amount of phosphorus as this dune sand contains would, however, sooner or later become exhausted, altho field experiments might not indicate a need for this element at first.

In the management of this type, the two things of first and by far the greatest importance are the addition of limestone and of organic matter. While this sand soil is not high in acidity, the samples examined were entirely devoid of limestone to a depth of more than 40 inches. For satisfactory results, therefore, an initial application of 3 to 4 tons per acre should be made, and this supply should be maintained by subsequent applications of about 2 tons every four or five years, or until conditions are established for the best growth of legumes.

Organic matter is needed to increase the moisture-retaining power, to furnish nitrogen, and to prevent blowing. Sand possesses very little cohesion, and is therefore readily moved by the wind. In fact, wind erosion on this soil is worse than water erosion on other soils, and unless some special means are used, especially on the more sandy areas, to prevent the movement by wind action, ultimate ruin of the soil will result. When organic matter is added, it acts as a feeble cement which, however, is sufficiently strong to bind the soil particles together and prevent blowing. In a test at this Station, the moisture-holding capacity of clean medium sand was increased 40 percent by the addition of 5 percent of peat, and 85.7 percent by the addition of 10 percent of peat.

When potash salts can be secured at reasonable cost, their use is likely to produce profitable results, at least temporarily, in getting under way systems of permanent improvement on this soil. This applies more especially to the level areas which were originally sandy swamps.

Corn on sand land "fires" very badly; that is, the lower leaves dry up. This is partly due to the fact that the soil is low in the element nitrogen and there is a translocation of the nitrogen from the lower to the upper leaves in order to continue growth. This drying up, which is usually attributed to lack of moisture, can be largely prevented by the presence of plenty of available nitrogen. The fact should be remembered that less moisture is required to produce a crop on a soil plentifully supplied with plant food than to produce one on a poor soil.

Rye is one of the hardy non-legumes often grown on sand soil, but this crop does not sufficiently cover the soil to protect it from blowing. Furthermore, it is a common practice to sell the straw as well as the grain, and this leaves very little organic matter to be turned back into the soil. A practice that could be followed to good advantage in favorable seasons would be to sow cowpeas after the rye, following the binder with the drill, and then later drilling rye in the cowpeas without cutting them or turning them under. This would serve to protect the soil from blowing as well as to furnish a supply of nitrogen and organic matter, and the practice would undoubtedly result in the improvement of this loose sandy type.

Cowpeas are well adapted to such soil, and they produce very large yields of excellent hay or grain very valuable for feed and seed. Under the best conditions and with good preparation, sweet clover can be grown in good seasons with proper soil treatment. With an abundance of limestone and moderate manuring, alfalfa can also be grown. More than five tons of alfalfa hay per acre in one year has been produced on an experiment field at Green Valley and similar results have been obtained on the Oquawka field. Sweet clover and alfalfa should be inoculated with the proper nitrogen-fixing bacteria.

Other possibilities of this type of soil may be shown by the use to which it is put in the vicinity of Wichert, where truck farming is carried on extensively. Where heavily manured, this dune sand has become very valuable for growing asparagus and other crops.

Foresting is a practical way of conserving these sand soils. The black locust (a leguminous tree) seems to do exceptionally well on sand. One difficulty with this tree, however, is that it is damaged by borers; but if it is used to start a

growth and hold the sand, other trees may then be interplanted and the result will be that the sand will be held permanently. After the blowing of sand is once stopped, very careful treatment is required to prevent a recurrence of the trouble. Pasturing should be done very carefully, because the grass is easily destroyed.

For an account of field experiments on dune sand see page 58 of the Supplement.

Yellow-Gray Silt Loam (1534)

Yellow-gray silt loam occurs in small areas along streams, particularly along the Iroquois river. It is very little different from the following type, yellow-gray silt loam over gravel, except that it appears to be of a later formation and the gravel does not occur.

The surface soil, 0 to 6⅔ inches, is a yellowish gray or yellowish brown silt loam with an organic-matter content of about 2.9 percent, or 29 tons per acre.

The subsurface is a yellowish or brownish yellow silt loam.

The subsoil is a yellow silt, in some places becoming rather heavy while in other places it is friable.

Management.—The treatment of this type should be the same as that of the yellow-gray silt loam over gravel (1536).

Yellow-Gray Silt Loam over Gravel (1536)

Yellow-gray silt loam over gravel occurs principally along the Iroquois river and Sugar creek, and is usually 25 to 30 feet above the bottom land. It covers an area of 6.37 square miles, or 4,077 acres.

The surface soil, 0 to 6⅔ inches, is a yellowish or grayish yellow silt loam, varying in sand content to a loam and in some places even to a sandy loam. The organic-matter content ranges from 1.8 to 3 percent, and averages 2.4 percent, or 24 tons per acre.

The subsurface is a yellow silt loam containing .8 percent of organic matter, or about 16 tons per acre.

The subsoil is a yellow silty material underlain by gravel, which in some places is less than 40 inches beneath the surface. It contains about .4 percent of organic matter.

Management.—In the management of this type, one of the first requirements is an application of 2 to 3 tons of limestone per acre to correct the acidity which in the subsoil becomes very high. The low content of organic matter indicates that it would be desirable to turn under all residues possible. Legumes should be grown and the best use made of straw, residues, and manure. Along with the improvement in this way, it would be of benefit to apply from ½ to 1 ton of rock phosphate per acre once in the rotation until the phosphorus content is well built up in the soil. This would be a good soil for alfalfa, as it is generally well drained, owing to the underlying stratum of gravel.

Brown Sandy Loam over Gravel (1566)

Brown sandy loam over gravel occurs along the Iroquois river and Sugar creek, and is formed in the same way as the preceding type (1536). It includes a total area of 3,187 acres.

The surface soil, 0 to 6⅔ inches, is a brown sandy loam varying on the one hand to brown silt loam, and on the other to sand. It contains about 2.9 percent of organic matter, or 29 tons per acre.

The subsurface is a brown sandy loam, passing into a yellowish sandy silt at a depth of about 15 inches. It contains about 1.6 percent of organic matter.

The subsoil is a yellow sandy silt varying to a silt. The gravel is sometimes found at a depth of less than 40 inches altho it usually occurs at greater depths.

Management.—In the samples examined the subsurface and subsoil strata were acid. Where this condition occurs it will be necessary to apply 2 or 3 tons of limestone per acre to secure the best results with legumes. The same use must be made of organic residues and manure as that indicated for the preceding type. Applications of phosphorus will aid in giving satisfactory results, both for legumes and for grain crops.

Yellow-Gray Sandy Loam over Gravel (1567)

Yellow-gray sandy loam over gravel occurs along the streams in a manner similar to that of the preceding type, but it has been timbered sufficiently long to reduce the organic matter to a very small amount. It covers an area of 3.30 square miles, or 2,112 acres.

The surface soil, 0 to 6⅔ inches, is a gray to light yellow sandy loam. It ranges in texture from a loam to a very sandy phase of sandy loam. It contains about 1.8 percent of organic matter, or 18 tons per acre.

The subsurface soil is a gray or yellowish gray sandy loam, passing into the heavier phase characteristic of the subsoil at a depth of about 15 to 17 inches.

The subsoil consists usually of a sandy clayey material that is underlain by gravel at a depth of 36 to 54 inches.

Management.—This type is very low in nitrogen, containing only 1,420 pounds per acre in the plowed soil. Legumes must be grown in order to increase the nitrogen content. Since the soil is very acid, it is necessary to apply 3 to 4 tons of limestone per acre to produce the best growth of legumes. All available organic residues and farmyard manure must be turned under in order to increase and maintain the supply of organic matter and nitrogen. This soil is also very low in phosphorus, and this element should be added.

Brown Silt Loam on Gravel (1526.4)

Brown silt loam on gravel occurs to a limited extent along Sugar creek in the vicinity of Woodland Junction. It covers only 211 acres.

The surface soil, 0 to 6⅔ inches, is lighter in color than the upland brown silt loam. It contains about 3 percent of organic matter.

The subsurface soil is a yellowish brown or brownish yellow silt loam.

The subsoil is a yellow sandy or gravelly silt loam passing into gravel at a depth of about 26 to 32 inches.

Management.—This type requires the same treatment as brown silt loam over gravel (1527) (see page 21). The gravel subsoil gives good drainage.

Black Clay Loam (1520)

Black clay loam of the terrace does not differ much from the upland black clay loam; hence the treatment that it should receive is practically the same. The reader is therefore referred to the discussion of black clay loam on page 13.

(d) SWAMP AND BOTTOM-LAND SOILS

This group includes the bottom lands along the streams, the swamps, and the poorly drained lowlands. Much of the soil, therefore, is of alluvial formation and the land is largely subject to overflow. The swamps were formerly what their name implies, but during the wettest part of the year at least they were shallow ponds or lakes. Seven types of this group are recognized in Iroquois county, the total area of which aggregates 48.76 square miles, or about 4.5 percent of the area of the county.

Deep Brown Silt Loam (1426)

Deep brown silt loam constitutes the larger part of the bottom land along the streams. Altho it varies slightly in some places, especially toward the northern part of the county, yet generally it consists of a brown silt loam, the dark color of which extends to a depth of 20 to 30 inches. It covers an area of 29.06 square miles, or 2.59 percent of the area of the county. At one time the terrace constituted the overflow land of the streams of the county, but later the streams cut below this terrace and began to develop a new flood plain that is the present first bottom land.

The surface soil, 0 to 6⅔ inches, is a brown silt loam containing from 5 to 7 percent of organic matter, or an average of 6 percent. The surface soil varies somewhat, owing to the deposition of sand in times of overflow.

The subsurface soil, 6⅔ to 20 inches, consists of a brown silt loam containing more or less sand. The organic-matter content is about 5.1 percent.

The subsoil varies from a brown silt loam to a yellowish or brownish yellow silt loam, and contains about 2.4 percent of organic matter.

Management.—This type contains a good supply of organic matter and nitrogen and has a phosphorus content varying from 1,200 to 1,600 pounds per acre in the plowed soil. The soil is usually either neutral or slightly acid, altho not so acid but that legumes will do well upon it. During times of overflow the type receives a deposit of rich soil. Therefore the most important requirement in its management is good cultivation. Large numbers of weed seed are deposited during flood times, and these are frequently a source of much trouble.

Mixed Loam (1454)

Mixed loam occurs principally as bottom land along Beaver creek in the northeastern part of the county. So much sand is carried into this stream that the bottom-land soil is badly mixed and it is therefore practically impossible to separate it into distinct types. Even if this could be done, the next flood would probably change the character of the soil. The area covered by this type amounts to 2,483 acres.

The surface soil, 0 to 6⅔ inches, is a mixed loam varying from a sand to a silt loam. It contains about 6.6 percent of organic matter.

The subsurface soil, 6⅔ to 20 inches, is a brown mixed loam with about 1.43 percent of organic matter.

The subsoil varies in somewhat the same way as the surface and is usually of a yellowish or brownish yellow color.

The type is of little importance so far as agriculture is concerned. It is used mainly for pasture.

Black Sandy Loam (1461)

Black sandy loam occurs in several isolated areas, the largest being in the northwest part of the county just south of the Marseilles moraine. This type covers an area of 12.61 square miles.

The surface soil, 0 to 6⅔ inches, is a black sandy loam varying on the one hand to a clayey sandy loam and on the other to a peaty loam. It contains about 5.3 percent of organic matter, or 53 tons per acre.

The natural subsurface consists of a stratum 8 to 12 inches thick, and varies from a brown to a yellowish brown sandy loam. This stratum usually contains sufficient amounts of the finer constituents, either clay or fine silt, to give it some tenacity. The organic-matter content of the stratum sampled is about 1.6 percent, or 32 tons per acre.

The subsoil consists of a pale yellow to grayish colored sandy clay or clayey sand and contains about .5 percent of organic matter.

Management.—The type needs drainage first, and while most areas have been drained, yet in some localities much more is needed. An occasional legume crop is desirable to aid in keeping the soil in good physical condition and in maintaining the nitrogen content. Where carbonates are absent, limestone should be applied in order to provide the most favorable conditions for the growth of legumes.

Peaty Loam on Sand (1410.2)

Peaty loam on sand covers only a small area, amounting to 288 acres.

The surface soil is a peaty loam consisting of organic matter and sand. The organic-matter content is about 19.8 percent, or 148.5 tons per acre.

The subsurface contains a little more than half the amount of organic matter that is found in the surface.

The subsoil is a gray or drab sand with only .8 percent of organic matter.

Management.—Proper drainage is of course essential in the successful cultivation of this kind of soil. Experience on soil of a similar nature has shown good returns from the use of manure and of potassium sulfate.

Deep Peat (1401)

Deep peat is found in small areas on both upland and terraces and covers 1,139 acres, or .16 percent of the area of the county. The soil to a depth of at least 30 inches consists largely of organic matter derived from mosses, sedges, and grasses.

The surface soil, 0 to 6⅔ inches, consists of a black or brownish peat, more or less decomposed. As a general rule, the drained areas have undergone greater decomposition because of better aeration, while the undrained areas have changed but little. The content of organic matter is about 59 percent, or 295 tons per acre.

The subsurface soil, 6⅔ to 20 inches, is a black or brownish peat that usually shows the texture of the material from which it was produced. The organic-matter content is about 31 percent.

The subsoil, 20 to 40 inches, is usually a brown peat, altho in small areas, sand, silt, or clay of a drab color may constitute the subsoil below 30 inches. The organic-matter content varies widely. The line between the peat and the mineral subsoil is usually very distinct.

Management.—Because of lack of drainage, this type of soil in Iroquois county has not been cultivated to a large extent. It is used mostly for pasture, and probably this is the best use to which it can be put. Tile drainage is not usually satisfactory because the soft peat soon permits the tile to get out of line and this seriously interferes with drainage.

Where thoro drainage can be provided either by open ditches or by laying tiles deep enough to secure a solid bed for them, very marked improvement can be made in the productive power of deep peat by the liberal use of potassium, which is by far the most deficient element. These soils frequently contain alkali that irritates the skin. The term "itch dirt" is often applied to them.

In the Supplement to this report are given the results obtained from field experiments on deep peat (see page 60).

Medium Peat on Clay (1402)

Medium peat on clay consists of a soil in which the peat is more than 12 and less than 30 inches in depth. Typically it is underlain by clay or silty clay, altho in some locations sand may occur instead of clay. This soil originates in the same way as deep peat. The total area in the county is 467 acres.

The surface soil, 0 to 6⅔ inches, is a brown or black peat, which may contain some sand. If the sand content becomes very high, the type passes into the peaty loam, a small area of which borders it on the south. The organic-matter content is about 36 percent.

The subsurface varies widely even in the same locality. The organic matter or peat may form a part of the subsurface or the entire stratum. The organic-matter content is approximately 9.8 percent.

The subsoil may be formed in part of peat. The mineral part consists of clay and sand but is distributed so irregularly that it is impossible to separate the areas into the two types. The clay subsoil seems to be the more prevalent. The organic-matter content is about 2.6 percent.

Management.—Drainage is one of the principal considerations in the management of the type. It may usually be provided without much difficulty because the clay affords a good bed for tile. The treatment for this type is likely to be the same as for deep peat, but thoro trials should be made with potassium in

advance of extensive use, for the surface and subsurface strata sometimes have sufficient potassium contained in the mineral particles deposited from repeated overflow.

Clayey Muck (1413)

Clayey muck is found in the northwestern part of the county in a few areas just south of the morainal ridge. These areas cover 160 acres.

The surface soil consists of a black, granular, plastic, clayey material having about 17.5 percent of organic matter.

The subsurface is very similar to the surface except that in its lower depths its assumes a slightly more drabbish color. It contains about 19 percent of organic matter.

The subsoil usually consists of a black to drabbish clay, waxy, but pervious to water. The sample collected contained about 10 percent of organic matter.

Management.—The upper strata of this soil contain no limestone but carbonates are found in the subsoil. Drainage is the first requirement, and after that good cultivation is about all that is necessary. The supply of potassium is abundant, as is also that of phosphorus, clayey muck being one of the richest soils of the county in this constituent. The rotation of crops is necessary in order to control insects and weeds.

APPENDIX

EXPLANATIONS FOR INTERPRETING THE SOIL SURVEY

CLASSIFICATION OF SOILS

In order to intelligently interpret the soil maps, the reader must understand something of the method of soil classification upon which the survey is based. Without going far into details the following paragraphs are intended to furnish a brief explanation of the general plan of classification here used.

The unit in the soil survey is the soil type, and each type possesses more or less definite characteristics. The line of separation between adjoining types is usually distinct, altho sometimes one type grades into another so gradually that it is very difficult to draw the line between them. In such exceptional cases, some slight variation in the location of soil-type boundaries is unavoidable.

In establishing soil types several factors must be taken into account. These are: (1) the geological origin of the soil, whether residual, cumulose, glacial, eolial, alluvial, or colluvial; (2) the topography, or lay of the land; (3) the native vegetation, as forest or prairie grasses; (4) the depth and the character of the surface, the subsurface, and the subsoil, as to the percentages of gravel, sand, silt, clay, and organic matter which they contain, their porosity, granulation, friability, plasticity, color, etc.; (5) the natural drainage; (6) the agricultural value, based upon its natural productiveness; (7) the ultimate chemical composition and reaction.

Great Soil Areas in Illinois.—On the basis of the first of the above mentioned factors, namely, the geological origin, the state of Illinois has been divided into sixteen great soil areas with respect to their geological formation. The names of these areas are given in the following list along with their corresponding index numbers, the use of which is explained below. For the location of these geological areas, the reader is referred to the general map published in Bulletins 123 and 193.

100 *Unglaciated,* comprizing three areas, the largest being in the south end of the state
200 *Illinoisan moraines,* including the moraines of the Illinoisan glaciation
300 *Lower Illinoisan glaciation,* covering nearly the south third of the state
400 *Middle Illinoisan glaciation,* covering about a dozen counties in the west-central part of the state
500 *Upper Illinoisan glaciation,* covering about fourteen counties northwest of the middle Illinoisan glaciation
600 *Pre-Iowan glaciation,* but now believed to be part of the upper Illinoisan
700 *Iowan glaciation,* lying in the central northern end of the state
800 *Deep loess areas,* including a zone a few miles wide along the Wabash, Illinois, and Mississippi rivers
900 *Early Wisconsin moraines,* including the moraines of the early Wisconsin glaciation
1000 *Late Wisconsin moraines,* including the moraines of the late Wisconsin glaciation
1100 *Early Wisconsin glaciation,* covering the greater part of the northeast quarter of the state
1200 *Late Wisconsin glaciation,* lying in the northeast corner of the state
1300 *Old river bottom and swamp lands,* found in the older or Illinoisan glaciation
1400 *Late river bottom and swamp lands,* those of the Wisconsin and Iowan glaciations
1500 *Terraces,* formed by overloaded streams draining from the glaciers and gravel outwash plains
1600 *Lacustrine deposits,* formed by Lake Chicago or the enlarged Lake Michigan

Mechanical Composition of Soils.—The mechanical composition, or the texture, is a most important feature in characterizing a soil. The texture depends upon the relative proportions of the following physical constituents:

Organic matter: undecomposed and partially decayed vegetable material

Inorganic matter: clay, silt, fine sand, sand, gravel, stones.

Classes of Soils.—Based upon the relative proportion of the various constituents mentioned above, soils may be grouped into a number of well recognized classes. Following is a list of these classes, arranged according to their index numbers, the use of which is explained below.

Index Number Limits	Class Names
0 to 9	Peats
10 to 12	Peaty loams
13 to 14	Mucks
15 to 19	Clays
20 to 24	Clay loams
25 to 49	Silt loams
50 to 59	Loams
60 to 79	Sandy loams
80 to 89	Sands
90 to 94	Gravelly loams
95 to 97	Gravels
98	Stony loams
99	Rock outcrop

Naming and Numbering Soil Types.—The naming of soil types has been the subject of much discussion, and practice varies considerably in this matter. In this soil survey of Illinois a system of classification and naming has been adopted which is based upon the various considerations presented in the preceding paragraphs.

After texture, one of the most striking characteristics of a soil is the color. Therefore, in the naming of soils in Illinois, a combination of color and texture, together with other descriptive terms when necessary, has been adopted so that the name in itself carries a definite description of a given soil type; as for example, "gray silt loam on tight clay," or "brown silt loam over gravel." The use of the prepositions *on* and *over* serves to indicate the presence of certain substrata. When the surface soil is underlain with material such as sand, gravel, or rock, the word *over* is used if this material lies at a depth greater than 30 inches; if it is less than 30 inches, the word *on* is used.

For further identification of soil types a system of numbering, resembling somewhat the Dewey library system, has been adopted whereby each soil type is assigned a certain number. This number indicates at once the geological origin of the soil as well as its physical description. The digits of the order of hundreds represent the geological area where the soil is found, beginning at 100 with the unglaciated, and following in series in the order of the enumeration presented in the paragraph above headed *Great Soil Areas In Illinois.* The digits of the orders of units and tens represent the various kinds of soil such as are enumerated above in the list of soil classes. A modification of a soil type called a *phase* is designated in this system by a figure placed at the right of the decimal point. To illustrate the working of this numbering system, suppose a soil type bears the number 726.5. The number 7 indicates that this soil occurs in the Iowan glaciation, the 26 that it is a brown silt loam, and the .5 that rock is found less than 30 inches below the surface. These numbers are especially useful in designating small areas on the map and as a check in reading the colors.

A complete list of the soil types occurring in each county, along with their corresponding type numbers and a description of the area covered, will be found in the respective county soil reports.

SOIL SURVEY METHODS

Mapping the Soil Types.—In conducting the soil survey, the county constitutes the unit of working area. In order that the survey be thoroly truthworthy it is necessary that careful, well-trained men be employed to do the mapping. The work is prosecuted to the best advantage by working in parties of from two to four. Only such men are placed in charge of these parties as are thoroly experienced in the work and have shown themselves to be especially well qualified in training and ability.

The men must be able to keep their location exactly and to recognize the different soil types, with their principal variations and limits, and they must show these upon the maps correctly. A definite system is employed in checking up this work. As an illustration, one man will survey and map a strip 80 rods or 160 rods wide and any convenient length, while his associate will work independently on another strip adjoining this area, and if the work is correctly done the soil-type boundaries will match up on the line between the two strips.

An accurate base map for field use is absolutely necessary for soil mapping. The base maps are prepared on a scale of one inch to the mile, the official data of the original or subsequent land survey being used as a basis in their construction. Each surveyor is provided with one of these base maps, which he carries with him in the field; and the soil-type boundaries, together with the streams, roads, railroads, canals, and town sites are placed in their proper locations upon the map while the mapper is on the area. Each section, or square mile, is divided into 40-acre plots on the map, and the surveyor must inspect every ten acres and determine the type or types of soil composing it. The different types are indicated on the map by different colors, pencils for this purpose being carried in the field.

A small auger 40 inches long forms for each man an invaluable tool with which he can quickly secure samples of the different strata for inspection. An extension for making the auger 80 inches long is taken by each party, so that any peculiarity of the deeper subsoil layers may be studied. Each man carries a compass to aid in keeping directions. Distances along roads are measured by an odometer attached to the axle of the vehicle or by some other measuring device, while distances in the field away from the roads are determined by pacing, an art in which the men become expert by practice. The soil boundaries can thus be located with as high a degree of accuracy as can be indicated by pencil on the scale of one inch to the mile.

Sampling for Analysis.—After all the soil types of a county have been located and mapped, samples representative of the different types are collected for chemical analysis. For this purpose usually three strata are sampled; namely, the surface (0 to 6⅔ inches), the subsurface (6⅔ to 20 inches), and the subsoil (20 to 40 inches). These strata correspond approximately, in the common kinds of soil, to 2,000,000 pounds of dry soil per acre in the surface layer, and to two times and three times this quantity in the subsurface and the subsoil, respectively.

By this system of sampling we have represented separately three zones for plant feeding. The surface layer includes at least as much soil as is ordinarily turned with the plow. This is the part with which the farm manure, limestone, phosphate, or other fertilizer applied in soil improvement is incorporated, and which must be depended upon in large part to furnish the necessary plant food for the production of crops. Even a rich subsoil has little or no value if it lies beneath a worn-out surface, but if the fertility of the surface soil is maintained at a high point, then the strong, vigorous plants will have power to secure more plant food from the subsurface and subsoil.

PRINCIPLES OF SOIL FERTILITY

Probably no agricultural fact is more generally known by farmers and landowners than that soils differ in productive power. Even tho plowed alike and at the same time, prepared the same way, planted the same day with the same kind of seed, and cultivated alike, watered by the same rains and warmed by the same sun, nevertheless the best acre may produce twice as large a crop as the poorest acre on the same farm, if not, indeed, in the same field; and the fact should be repeated and emphasized that with the normal rainfall of Illinois the productive power of the land depends primarily upon the stock of plant food contained in the soil and upon the rate at which it is liberated, just as the success of the merchant depends primarily upon his stock of goods and the rapidity of sales. In both cases the stock of any commodity must be increased or renewed whenever the supply of such commodity becomes so depleted as to limit the success of the business, whether on the farm or in the store.

CROP REQUIREMENTS

Ten different elements of plant food are essential for the growth and formation of every plant. These elements are: *carbon, oxygen, hydrogen, nitrogen, phosphorus, sulfur, potassium, magnesium, calcium, and iron;* and they are represented by the chemical symbols: C, O, H, N, P, S, K, Mg, Ca, and Fe. Some seasons in central Illinois are sufficiently favorable to allow the production of at least 50 bushels of wheat per acre, 100 bushels of corn, 100 bushels of oats, and 4 tons of clover hay. When such crops are not produced under favorable seasonal conditions, the failure is due to unfavorable soil condition, which may

TABLE A.—PLANT FOOD IN WHEAT, CORN, OATS, AND CLOVER

Produce: Kind	Produce: Amount	Nitrogen	Phosphorus	Sulfur	Potassium	Magnesium	Calcium	Iron
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Wheat, grain.....	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat straw.....	1 ton	10.00	1.60	2.70	18.00	1.60	3.80	.60
Corn, grain.......	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn stover......	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs........	1 ton	4.00	.....	.....	4.00	.....	.....	.....
Oats, grain.......	1 bu.	.66	.11	.06	.16	.04	.02	.01
Oat straw........	1 ton	12.40	2.00	4.14	20.80	2.80	6.00	1.12
Clover seed.......	1 bu.	1.75	.50	.....	.75	.25	.13	.....
Clover hay.......	1 ton	40.00	5.00	3.28	30.00	7.75	29.25	1.00

result from poor drainage, poor physical condition, or an actual deficiency of plant food.

Table A shows the plant-food requirements of some of our most common field crops with respect to the seven elements furnished by the soil. The figures show the weight in pounds of the various elements contained in a bushel or in a ton, as the case may be. From these data the amount of any element removed from an acre of land by a crop of a given yield can easily be computed.

It needs no argument to show that the continuous removal of such quantities of plant food without provision for their replacement must result sooner or later in soil depletion.

PLANT-FOOD SUPPLY

Of the ten elements of plant food, three *(carbon, oxygen,* and *hydrogen)* are secured from air and water, and seven from the soil. *Nitrogen,* one of these seven elements obtained from the soil by all plants, may also be secured from the air by one class of plants (legumes), in case the amount liberated from the soil is insufficient; but even these plants (which include only the clovers, peas, beans, and vetches among our common agricultural plants) are dependent upon the soil for the other six elements *(phosphorus, potassium, magnesium, calcium, iron, and sulfur),* and they also utilize the soil nitrogen so far as it becomes soluble and available during their period of growth.

TABLE B.—PLANT-FOOD ELEMENTS IN MANURE, ROUGH FEEDS, AND FERTILIZERS

Material	Pounds of plant food per ton of material		
	Nitrogen	Phosphorus	Potassium
Fresh farm manure	10	2	8
Corn stover	16	2	17
Oat straw	12	2	21
Wheat straw	10	2	19
Clover hay	40	5	30
Cowpea hay	43	5	33
Alfalfa hay	50	4	24
Sweet clover (water-free basis)[1]	80	8	28
Dried blood	280	...	...
Sodium nitrate	310	...	...
Ammonium sulfate	400	...	...
Raw bone meal	80	180	...
Steamed bone meal	20	250	...
Raw rock phosphate	...	250	...
Acid phosphate	...	125	...
Potassium chlorid	...	...	850
Potassium sulfate	...	...	850
Kainit	...	...	200
Wood ashes[2]	...	10	100

[1]Young second year's growth ready to plow under as green manure.
[2]Wood ashes also contain about 1,000 pounds of lime (calcium carbonate) per ton.

The vast difference with respect to the supply of these essential plant food elements in different soils is well brought out in the data of the Illinois soil survey. For example, it has been found that the nitrogen in the surface 6⅔ inches, which represents the plowed stratum, varies in amount from 180 pounds per acre to nearly 33,000 pounds. In like manner the phosphorus content varies from about 420 pounds to 4,900 pounds, the potassium ranges from 1,530 pounds to about 58,000 pounds. Similar variations are found in all of the other essential plant food elements of the soil.

With these facts in mind it is easy to understand how a deficiency of one of these elements of plant food may become a limiting factor of crop production. When an element becomes so reduced in quantity as to become a limiting factor of production, then we must look for some outside source of supply. Table B is presented for the purpose of furnishing information regarding the quantity of plant food contained in some of the materials most commonly used as sources of plant-food supply.

LIBERATION OF PLANT FOOD

The chemical analysis of the soil gives the invoice of fertility actually present in the soil strata sampled and analyzed, but the rate of liberation is governed by many factors, some of which may be controlled by the farmer, while others are largely beyond his control. Chief among the important controllable factors which influence the liberation of plant food are limestone and decaying organic matter. Tillage also has a considerable effect in this connection.

Effect of Limestone.—Limestone corrects the acidity of the soil and thus encourages the development not only of the nitrogen-gathering bacteria which live in the nodules on the roots of clover, cowpeas, and other legumes, but also the nitrifying bacteria, which have power to transform the insoluble and unavailable organic nitrogen into soluble and available nitrate nitrogen. At the same time, the products of this decomposition have power to dissolve the minerals contained in the soil, such as potassium and magnesium, and also to dissolve the insoluble phosphate and limestone which may be applied in low-priced forms. Thus, in the conversion of sufficient organic nirogen into nitrate nitrogen for a 100-bushel crop of corn, the nitrous acid formed is alone sufficient to convert seven times as much insoluble tricalcium phosphate into soluble monocalcium phosphate as would be required to supply the phosphorus for the same crop.

Effect of Organic Matter.—Organic matter may be supplied by animal manures, consisting of the excreta of animals and usually accompanied by more or less stable litter, and by plant manures, including green-manure crops and cover crops plowed under and also crop residues such as stalks, straw, and chaff. The rate of decay of organic matter depends largely upon its age, condition, and origin, and it may be hastened by tillage. The chemical analysis shows correctly the total organic carbon, which constitutes, as a rule, but little more than half the organic matter; so that 20,000 pounds of organic carbon in the plowed soil of an acre corresponds to nearly 20 tons of organic matter. But this organic matter consists largely of the old organic residues that have accumulated during the past centuries because they were resistant to decay, and 2 tons of clover or cowpeas plowed under may have greater power to liberate plant food than the 20 tons of old, inactive organic matter. The history of the individual

farm or field must be depended upon for information concerning recent additions of active organic matter, whether in applications of farm manure, in legume crops, or in sods of old pastures.

The condition of the organic matter of the soil is indicated more or less definitely by the *ratio of carbon to nitrogen.* As an average, the fresh organic matter incorporated with soils contains about twenty times as much carbon as nitrogen, but the carbohydrates ferment and decompose much more rapidly than the nitrogenous matter; and the old resistant organic residues, such as are found in normal subsoils, commonly contain only five or six times as much carbon as nitrogen. Soils of normal physical composition, such as loam, clay loam, silt loam, and fine sandy loam, when in good productive condition, contain about twelve to fourteen times as much carbon as nitrogen in the surface soil; while in old, worn soils that are greatly in need of fresh, active, organic manures, the ratio is narrower, sometimes falling below ten of carbon to one or nitrogen. Except in newly made alluvial soils, the ratio is usually narrower in the subsurface and subsoil than in the surface stratum. Soils of cut-over or burnt-over timber lands sometimes contain so much partially decayed wood or charcoal as to destroy the value of the nitrogen-carbon ratio for the purpose indicated.

The organic matter furnishes food for bacteria, and as it decays certain decomposition products are formed, including much carbonic acid, some nitrous acid, and various organic acids, and these acting upon the soil have the power to dissolve the essential mineral plant foods, thus furnishing soluble phosphates, nitrates, and other salts of potassium, magnesium, calcium, etc., for the use of the growing crop.

Effect of Tillage.—Tillage, or cultivation, also hastens the liberation of plant food by permitting the air to enter the soil. It should be remembered, however, that tillage is wholly destructive, in that it adds nothing whatever to the soil, but always leaves it poorer, so far as plant food is concerned. Tillage should be practiced so far as is necessary to prepare a suitable seed bed for root development and also for the purpose of killing weeds, but more than this is unnecessary and unprofitable; and it is much better actually to enrich the soil by proper applications of limestone, organic matter and other fertilizing materials, and thus promote soil conditions favorable for vigorous plant growth, than to depend upon excessive cultivation to accomplish the same object at the expense of the soil.

PERMANENT SOIL IMPROVEMENT

According to the kind of soil involved, any comprehensive plan contemplating a permanent system of agriculture will need to take into account some of the following considerations.

The Application of Limestone

The Function of Limestone.—In considering the application of limestone to land it should be understood that this material functions in several different ways, and that a beneficial result may therefore be attributable to quite diverse causes: Limestone provides the plant food calcium, of which certain crops are strong feeders. It corrects acidity of the soil, thus making for some crops a much

more favorable environment as well as establishing conditions absolutely required for some of the beneficial legume bacteria. It accelerates nitrification and nitrogen fixation. It promotes sanitation of the soil by preventing the growth of certain fungus diseases, such as corn root rot. Experience indicates that it modifies directly the physical structure of some soils, frequently to their great improvement.

Thus, working in one or more of these different ways, limestone often becomes the key to the improvement of worn lands. Remarkable success has been experienced with limestone used in conjunction with sweet clover in the reclamation of abandoned hill land which had been ruined thru erosion.

Amounts to Apply.—If the soil is acid, at least 2 tons per acre of ground limestone should be applied as an initial treatment. Continue to apply limestone from time to time according to the requirement of the soil as indicated by the tests described below, or until the most favorable conditions are established for the growth of legumes, using preferably at times magnesian limestone ($CaCO_3MgCO_3$), which contains both calcium and magnesium and has slightly greater power to correct soil acidity, ton for ton, than the ordinary calcium limestone ($CaCO_3$). On strongly acid soils, or on land being prepared for alfalfa, 4 or 5 tons per acre of ground limestone may well be used for the first application.

How to Ascertain the Need for Limestone.—The need of a soil for limestone may be ascertained by applying one of the following tests for soil acidity. Along with the acidity test, a test for the presence of carbonates should be made. It should be understood that a positive test for carbonates does not guarantee the absence of acid; for it may happen, especially when the soil is near the neutral point, that positive tests for both acidity and carbonates are obtained. This condition is explained by the assumption that solid particles of calcium or magnesium carbonates form centers of alkalinity within a soil that is generally acid. Because of this fact any test made of a given soil ought to be repeated if it is to be thoroly reliable. It is also desirable to test samples from different depths. Following are the directions for making these tests:

The Litmus Paper Test for Acidity. Make a ball of fresh moist soil, break it in two, insert a piece of blue litmus paper, and press the soil firmly together again. After a few minutes examine the paper. If it has turned pink or red, soil acidity is indicated. The intensity of the color and the rapidity with which it develops indicates to some extent the amount of acidity. Needless to say the reliability of the test depends upon the quality of litmus paper used.

The Potassium Thiocyanate Test for Acidity. A more recently discovered test for soil acidity which promises to be more satisfactory than the litmus test is made with a 4-percent solution of potassium thiocyanate in alcohol—4 grams of potassium thiocyanate in 100 cubic centimeters of 95-percent alcohol (not denatured). When a small quantity of soil shaken up in a test tube with this solution gives a red color the soil is acid and limestone should be applied. If the solution remains colorless the soil is not acid. The conditions for a prompt reaction require a temperature that is comfortably warm.

The Hydrochloric Acid Test for Carbonates. Make a shallow cup of a ball of soil and pour into it a few drops of concentrated hydrochloric acid. If carbonates are present they are decomposed with the liberation of carbon dioxid, which appears as gas bubbles, producing foaming or effervescence. With much carbonate present the action is lively, but with mere traces of it the bubbles are given off slowly. If no carbonate, or very little, is indicated by the test, then it is advisable to apply limestone.

The Nitrogen Problem

Nitrogen presents the greatest practical soil problem in American agriculture. Four important reasons for this are: its increasing deficiency in most soils; its cost when purchased on the open market; its removal in large amounts by crops; and its loss from soils thru leaching. Nitrogen costs from four to

five times as much per pound as phosphorus. A 100-bushel crop of corn requires 150 pounds of nitrogen for its growth, but only 23 pounds of phosphorus. The loss of nitrogen from soils may vary from a few pounds to over one hundred pounds per acre, depending upon the treatment of the soil, the distribution of rainfall, and the protection afforded by growing crops.

An inexhaustible supply of nitrogen is present in the air. Above each acre of the earth's surface there are about sixty-nine million pounds of atmospheric nitrogen. The nitrogen above one square mile weighs twenty million tons, an amount sufficient to supply the entire world for four or five decades. This large supply of nitrogen in the air is the one to which the world must eventually turn.

There are two methods of collecting the inert nitrogen gas of the air and combining it into compounds that will furnish products for agricultural uses. *These are the chemical and the biological fixation of the atmospheric nitrogen.* Farmers have at their command one of these methods. By growing inoculated legumes, nitrogen may be obtained from the air, and by plowing under more than the roots of those legumes, nitrogen may be added to the soil.

Inasmuch as legumes are worth growing for feed and seed as well as for nitrate production, a considerable portion of the nitrogen thus gained may be considered a by-product. Because of that fact, it is questionable whether the chemical fixation of nitrogen, the possibilities of which now represent numerous compounds, will ever be able to replace the simple method of obtaining atmospheric nitrogen by growing inoculated legumes.

For easy figuring it may well be kept in mind that the following amounts of nitrogen are required for the produce named:

1 bushel of oats (grain and straw) requires 1 pound of nitrogen.
1 bushel of corn (grain and stalks) requires 1½ pounds of nitrogen.
1 bushel of wheat (grain and straw) requires 2 pounds of nitrogen.
1 ton of timothy requires 24 pounds of nitrogen.
1 ton of clover contains 40 pounds of nitrogen.
1 ton of cowpeas contains 43 pounds of nitrogen.
1 ton of alfalfa contains 50 pounds of nitrogen.
1 ton of average manure contains 10 pounds of nitrogen.
1 ton of young sweet clover, at about the stage of growth when it is plowed under as green manure, contains, on water-free basis, 80 pounds of nitrogen.

The roots of clover contain about half as much nitrogen as the tops, and the roots of cowpeas contain about one-tenth as much as the tops. Soils of moderate productive power will furnish as much nitrogen to clover (and two or three times as much to cowpeas) as will be left in the roots and stubble. In grain crops, such as wheat, corn, and oats, about two-thirds of the nitrogen is contained in the grain and one-third in the straw or stalks.

The Phosphorus Problem

The element phosphorus is an indispensable constituent of every living cell. It is intimately connected with the life processes of both plants and animals, the nuclear material of the cells being especially rich in this element.

The phosphorus content of a soil varies according to its origin and the kind of farming practiced. Even virgin soils are found that are deficient in phosphorus.

On all lands deficient in phosphorus (except on those susceptible to serious erosion by surface washing or gullying) that element should be applied in considerably larger amounts than are required to meet the actual needs of the crops desired to be produced. The abundant information thus far secured shows positively that fine-ground natural rock phosphate can be used successfully and very profitably, and clearly indicates that this material will be the most economical form of phosphorus to use in all ordinary systems of permanent, profitable soil improvement. The first application may well be one ton per acre, and subsequently about one-half ton per acre every four or five years should be applied, at least until the phosphorus content of the plowed soil reaches 2,000 pounds per acre, which may require a total application of from 3 to 5 or 6 tons per acre of raw phosphate containing 12½ percent of the element of phosphorus.

Steamed bone meal and even acid phosphate may be used in emergencies, but it should always be kept in mind that a pound of phosphorus delivered in Illinois in the form of raw phosphate (direct from the mine in carload lots), is much cheaper than the same amount in steamed bone meal or in acid phosphate, both of which cost too much per ton to permit their common purchase by farmers in carload lots, which is not the case with raw phosphate. Landowners should bear in mind the fact that phosphorus additions to the soil in amounts above the immediate crop requirements represent a permanent investment, since this element is not readily lost in the drainage water as in the case of nitrogen. It is removed from the farm thru the sale of crops, milk, and animals.

Phosphate may be applied at any time during a rotation, but it is applied to the best advantage either preceding a crop of clover, which plant seems to possess an unusual power for assimilating raw phosphate, or else at a time when it can be plowed under with some form of organic matter such as animal manure or green manure, the decay of which serves to liberate the phosphorus from its insoluble condition in the rock. It is important that the fine-ground rock phosphate be intimately mixed with the organic material as it is plowed under.

The Potassium Problem

Normal soils, in which clay and silt form a considerable part of the constituency, are well stocked with potassium, altho it exists largely in insoluble form. Such soils as sands and peats, however, are likely to be low in this element. On such soils this deficiency may be supplied by the application of some potassium salt, such as potassium sulfate, potassium chlorid, kainit, or other potassium compound, and in many instances this is done at great profit.

From all the facts at hand it seems, so far as our great areas of normal soils are concerned, that the potassium problem is not one of addition but of liberation. The Rothamsted records, which represent the oldest soil experiment fields in the world, show that for many years other soluble salts have practically the same power as potassium to increase crop yield in the absence of sufficient decaying organic matter. Whether this action relates to supplying or liberating potassium for its own sake, or to the power of the soluble salt to increase the availability of phosphorus or other elements, is not known, but where much

potassium is removed, as in the entire crops at Rothamsted, with no return of organic residues, probably the soluble salt functions in both ways.

Further evidence on this matter is furnished by the Illinois experiment field at Fairfield, where potassium sulfate has been compared with kainit both with and without the addition of organic matter in the form of stable manure. Both sulfate and kainit produced a substantial increase in the yield of corn, but the cheaper salt, kainit, was just as effective as the potassium sulfate, and returned some financial profit. Manure alone gave an increase similar to that produced by the potassium salts, but the salts added to the manure gave very little increase over that produced by the manure alone. This is explained in part perhaps because the potassium removed in the crops is mostly returned in the manure if properly cared for, and perhaps in larger part because the decaying organic matter helps to liberate and hold in solution other plant-food elements, especially phosphorus.

In laboratory experiments at the Illinois Experiment Station, it has been shown that potassium salts and most other soluble salts increase the solubility of the phosphorus in soil and in rock phosphate; also that the addition of glucose with rock phosphate in pot-culture experiments increases the availability of the phosphorus, as measured by plant growth, altho the glucose consists only of carbon, hydrogen, and oxygen, and thus contains no plant food of value.

In considering the conservation of potassium on the farm it should be remembered that in average live-stock farming the animals destroy two-thirds of the organic matter and retain one-fourth of the nitrogen and phosphorus from the food they consume, but that they retain less than one-tenth of the potassium; so that the actual loss of potassium in the products sold from the farm, either in grain farming or in live-stock farming, is negligible on land containing 25,000 pounds or more of potassium in the surface 6⅔ inches.

The Calcium and Magnesium Problem

When measured by the actual crop requirements for plant food, magnesium and calcium are more limited in some Illinois soils than potassium. But with these elements we must also consider the loss by leaching.

Doctor Edward Bartow and associates, of the Illinois State Water Survey, have shown that as an average of 90 analyses of Illinois well-waters drawn chiefly from glacial sands, gravels, or till, 3 million pounds of water (about the average annual drainage per acre for Illinois) contained 11 pounds of potassium, 130 of magnesium, and 330 of calcium. These figures are very significant, and it may be stated that if the plowed soil is well supplied with the carbonates of magnesium and calcium, then a very considerable proportion of these amounts will be leached from that stratum. Thus the loss of calcium from the plowed soil of an acre at Rothamsted, England, where the soil contains plenty of limestone, has averaged more than 300 pounds a year as determined by analyzing the soil in 1865 and again in 1905. And practically the same amount of calcium was found by analyzing the Rothamsted drainage waters.

Common limestone, which is calcium carbonate ($CaCO_3$), contains, when pure, 40 percent of calcium, so that 800 pounds of limestone is equivalent to 320 pounds of calcium. Where 10 tons per acre of ground limestone was applied at Edgewood, Illinois, the average annual loss during the next ten

years amounted to 790 pounds per acre. The definite data from careful investigations seems to be ample to justify the conclusion that where limestone is needed at least 2 tons per acre should be applied every four or five years.

It is of interest to note that thirty crops of clover of 4 tons each would require 3,510 pounds of calcium, while the most common prairie land of southern Illinois contains only 3,420 pounds of total calcium in the plowed soil of an acre. Thus limestone has a positive value on some soils for the plant food which it supplies, in addition to its value in correcting soil acidity and in improving the physical condition of the soil. Ordinary limestone (abundant in the southern and western parts of the state) contains nearly 800 pounds of calcium per ton; while a good grade of dolomitic limestone (the more common limestone of northern Illinois) contains about 400 pounds of calcium and 300 pounds of magnesium per ton. Both of these elements are furnished in readily available form in ground dolomitic limestone.

The Sulfur Question

In considering the relation of sulfur in a permanent system of soil fertility it is important to understand something of the cycle of transformations that this element undergoes in nature. Briefly stated this is as follows:

Sulfur exists in the soil in both organic and inorganic forms, the former being gradually converted to the latter form thru bacterial action. In this inorganic form sulfur is taken up by plants which in their physiological processes change it once more into an organic form as a constituent of protein. When these plant proteins are consumed by animals, the sulfur becomes a part of the animal protein. When these plant and animal proteins are decomposed, either thru bacterial action, or thru combustion, the sulfur passes into the atmosphere or into the soil solution in the form of sulfur dioxid gas. This gas unites with oxygen and water to form sulfuric acid, which is readily washed back into the soil by the rain, thus completing the cycle, from soil—to plants and animals—to air—to soil.

In this way sulfur becomes largely a self-renewing element of the soil, altho there is a considerable loss from the soil by leaching. Observations taken at the Illinois Agricultural Experiment Station show that 40 pounds of sulfur per acre are brought into the soil thru the annual rainfall. With a fair stock of surfur, such as exists in our common types of soil, and an annual return, which of itself would more than suffice for the needs of maximum crops, the maintenance of an adequate sulfur supply presents little reason at present for serious concern. There are regions, however, where the natural stock of sulfur in the soil is not nearly so high and where the amount returned thru rainfall is small. Under such circumstances sulfur soon becomes a limiting element of crop production, and it will be necessary sooner or later to introduce this substance from some outside source. Investigation is now under way to determine to what extent this situation may apply to conditions in Illinois.

Physical Improvement of Soils

In the management of most soil types, one very important thing, aside from proper fertilization, tillage, and drainage, is to keep the soil in good physical condition, or good tilth. The constituent most important for this purpose is

organic matter. Organic matter in producing good tilth helps to control washing of soil on rolling land, raises the temperature of drained soil, increases the moisture-holding capacity of the soil, retards capillary rise and consequently loss of moisture by surface evaporation, and helps to overcome the tendency of some soils to run together badly.

The physical effect of organic matter is to produce a granulation or mellowness, by cementing the fine soil particles into crumbs or grains about as large as grains of sand, which produces a condition very favorable for tillage, percolation of rainfall, and the development of plant roots.

Organic matter is being destroyed during a large part of the year and the nitrates produced in its decomposition are used for plant growth. Altho this decomposition is necessary, it nevertheless reduces the amount of organic matter, and provision must therefore be made for maintaining the supply. The practical way to do this is to turn under the farm manure, straw, corn stalks, weeds, and all or part of the legumes produced on the farm. The amount of legumes needed depends upon the character of the soil. There are farms, especially grain farms, in nearly every community where all legumes could be turned under for several years to good advantage.

Manure should be spread upon the land as soon as possible after it is produced, for if it is allowed to lie in the barnyard several months as is so often the case, from one-third to two-thirds of the organic matter will be lost.

Straw and corn stalks should be turned under, and not burned. Probably no form of organic matter acts more beneficially in producing good tilth than corn stalks. It is true, they decay rather slowly, but it is also true that their durability in the soil is exactly what is needed in the production of good tilth. Furthermore, the nitrogen in a ton of corn stalks is one and one-half times that of a ton of manure, and a ton of dry corn stalks incorporated in the soil will ultimately furnish as much humus as four tons of average farm manure. When burned, however, both the humus-making material and the nitrogen are lost to the soil.

It is a common practice in the corn belt to pasture the corn stalks during the winter and often rather late in the spring after the frost is out of the ground. This tramping by stock sometimes puts the soil in bad condition for working. It becomes partially puddled and will be cloddy as a result. If tramped too late in the spring, the natural agencies of freezing and thawing and wetting and drying, with the aid of ordinary tillage, fail to produce good tilth before the crop is planted. Whether the crop is corn or oats, it necessarily suffers, and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats, the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling which is unfavorable to physical, chemical, and biological processes. The bad effect will be greater if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Systems of Crop Rotations

In a program of permanent soil improvement one should adopt at the outset a good rotation of crops, including a liberal use of legumes, in order to increase the organic matter of the soil either by plowing under the legume crops and

other crop residues (straw and corn stalks), or by using for feed and bedding practically all the crops raised and returning the manure to the land with the least possible loss. No one can say in advance for every particular case what will prove to be the best rotation of crops, because of variation in farms and farmers and in prices for produce.

Following are a few suggested rotations, applicable to the corn belt, which may serve as models or outlines to be modified according to special circumstances.

Six-Year Rotations

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover) or grass and clover
Sixth year —Clover, or clover and grass

Of course there should be as many fields as there are years in the rotation. In grain farming, with small grain grown the third and fifth years, most of the unsalable products should be returned to the soil, and the clover may be clipped and left on the land or returned after threshing out the seed (only the clover seed being sold the fourth and sixth years); or, in live-stock farming, the field may be used three years for timothy and clover pasture and meadow if desired. The system may be reduced to a five-year rotation by cutting out either the second or the sixth year, and to a four-year system by omitting the fifth and sixth years, as indicated below.

Five-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover, or clover and grass)
Third year —Clover, or clover and grass
Fourth year —Wheat (with clover), or clover and grass
Fifth year —Clover, or clover and grass

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover)

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover
Fifth year —Wheat (with clover)

The last rotation mentioned above allows legumes to be seeded four times. Alfalfa may be grown on a sixth field for five or six years in the combination rotation, alternating between two fields every five years, or rotating over all the fields if moved every six years.

Four-Year Rotations

First year —Wheat (with clover)
Second year —Corn
Third year —Oats (with clover)
Fourth year —Clover

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover)
Fourth year —Clover

First year —Corn
Second year —Wheat or oats (with colver)
Third year —Clover
Fourth year —Wheat (with clover)

First year —Wheat (with clover)
Second year —Clover
Third year —Corn
Fourth year —Oats (with clover)

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover

Alfalfa may be grown on a fifth field for four or eight years, which is to be alternated with one of the four; or the alfalfa may be moved every five years, and thus rotated over all five fields every twenty-five years.

Three-Year Rotations

First year —Corn
Second year —Oats or wheat (with clover)
Third year —Clover

First year —Wheat (with clover)
Second year —Corn
Third year —Cowpeas or soybeans

By allowing the clover, in the last rotation mentioned, to grow in the spring before preparing the land for corn, we have provided a system in which legumes grow on every acre every year. This is likewise true of the following suggested two-year system:

Two-Year Rotation

First year —Oats or wheat (with sweet clover)
Second year —Corn

Altho in this two-year rotation either oats or wheat is suggested, as a matter of fact, by dividing the land devoted to small grain, both of these crops can be grown simultaneously, thus providing a three-crop system in a two-year cycle.

It should be understood that in all of the above suggested cropping systems it may be desirable in some cases to substitute rye for the wheat or oats. In all of these proposed rotations the word *clover* is used in a general sense to designate either red clover, alsike clover, or sweet clover. The value of sweet clover especially as a green manure for building up depleted soils, as well as a pasture and hay crop, is becoming thoroly established, and its importance in a crop-rotation program may well be emphasized.

SUPPLEMENT: EXPERIMENT FIELD DATA

(Results from Experiment Fields Representing the More Important Types of Soil Occurring in Iroquois County)

In the earlier reports of this series it was the practice to incorporate in the body of the report the results of certain experiment fields, for the purpose of illustrating the possibilities of improving the soil of various types. The information carried by such data must, naturally, be considered more or less tentative. As the fields grow older new facts develop, which in some instances may call for the modification of former recommendations. It has therefore seemed desirable to separate this experiment field data from the more permanent information of the soil survey, and embody the same in the form of a supplement to the soil report proper, thus providing a convenient arrangement for possible future revisions as further data accumulate.

The University of Illinois has conducted altogether about fifty soil experiment fields in different sections of the state and on various types of soil. Altho some of these fields have been discontinued, the large majority are still in operation. It is the present purpose to report the summarized results from certain of these fields which are representative of the types of soil described in the accompanying soil report.

A few general explanations at this point, which apply to all the fields, will relieve the necessity of numerous repetitions in the following pages.

These fields vary in size from less than two acres up to 40 acres or more. They are laid off into series of plots and each series is occupied by one kind of crop. Usually there are several series so that a crop rotation can be carried on with every crop represented every year.

Farming Systems

On many of the fields the treatment provides for two distinct systems of farming, live-stock and grain farming. *In the live-stock system,* stable manure is used to furnish organic matter and nitrogen. The amount applied to a plot is based upon the amount that can be produced from crops raised on that plot.

In the grain system no animal manure is used. The organic matter and nitrogen are supplied in the form of plant manures, including plant residues produced, such as stalks and straw, along with leguminous catch crops plowed under.

Rotations

Crops which are of interest in the respective localities are grown in definite rotations, and on most of the fields provision is made so that every crop in the rotation is represented every year. The most common rotation used is wheat, corn, oats, and clover; and often these crops are accompanied by alfalfa growing on a fifth series. In the grain system a legume catch crop, usually sweet clover, is included, which is seeded on the young wheat in the spring and plowed under in the fall or in the following spring in preparation for corn. In the event of clover failure, soybeans are substituted.

Soil Treatment

The treatment applied to the plots has, for the most part, been standardized according to a definite system, altho deviations from this system occur now and then, particularly in the older fields.

Following is a brief explanation of this standard system of treatment.

Animal Manures.—Animal manures, consisting of excreta from animals, with stable litter, are spread upon the respective plots in amounts proportionate to previous crop yields, the applications being made in the preparation for corn.

Plant Manures.—Crop residues produced on the land, such as stalks, straw, and chaff, are returned to the soil, and in addition a green-manure crop of sweet clover is seeded in small grains to be plowed under in preparation for corn. (On plots where limestone is lacking the sweet clover seldom survives.) This practice is designated as the *residues system.*

Mineral Manures.—The yearly acre-rates of application are: for limestone, 1,000 pounds; for raw rock phosphate, 500 pounds; and for potassium, the equivalent of 200 pounds of kainit. The initial application of limestone is usually 4 tons per acre.

Explanation of Symbols Used

0 = Untreated land or check plots
M = Manure (animal)
R = Residues (from crops, and includes legumes used as green manure)
L = Limestone
P = Phosphorus
K = Potassium (usually in the form of kainit)
N = Nitrogen (usually in the form contained in dried blood)
( ) = Parentheses enclosing figures signify tons of hay, as distinguished from bushels of seed

In discussions of this sort of data, financial profits or losses based upon assigned market values are frequently considered. However, in view of the erratic fluctuations in market values—especially in the past few years—it seems futile to attempt to set any prices for this purpose that are at all satisfactory. The yields are therefore presented with the thought that with these figures at hand the financial returns from a given practice can readily be computed upon the basis of any set of market values that the reader may choose to apply.

BROWN SILT LOAM

Several experiment fields have been conducted on brown silt loam soil at various locations in Illinois. Those located at the University have been in operation the longest and they serve well to illustrate the principles involved in the maintenance and improvement of this type of soil.

The Morrow Plots

It happens that the oldest soil experiment field in the United States is located on typical brown silt loam of the early Wisconsin glaciation, on the campus of the University of Illinois. This field was started in 1879 by George E. Morrow, who for many years was Professor of Agriculture, and these plots are known as the Morrow plots.

TABLE 1.—URBANA FIELD, MORROW PLOTS: BROWN SILT LOAM; PRAIRIE; EARLY WISCONSIN GLACIATION

Crop Yields in Soil Experiments—Bushels or (tons) per acre

Years	Soil treatment applied	Corn every year	Two-year rotation		Three-year rotation		
		Corn	Corn	Oats	Corn	Oats	Clover
1879-87	None.......	....	....	....	....	....	....
1888	None.......	54.3	49.5	....	....	48.6	....
1889	None.......	43.2	....	37.4	....	....	(4.04)
1890	None.......	48.7	54.3	....	....	....	(1.51)
1891	None.......	28.6	33.2	....	....	....	(1.46)
1892	None.......	33.1	....	37.2	70.2	....	....
1893	None.......	21.7	29.6	....	34.1	....	....
1894	None.......	34.8	....	57.2	....	65.1	....
1895	None.......	42.2	41.6	....	....	22.2	....
1896	None.......	62.3	....	34.5	....	....	....
1897	None.......	40.1	47.0	....	....	....	....
1898	None.......	18.1	....	....	....	....	....
1899	None.......	50.1	44.4	....	53.5	....	....
1900	None.......	48.0	....	41.5	....	....	....
1901	None.......	23.7	33.7	....	34.3	....	....
1902	None.......	60.2	....	56.3	....	54.6	....
1903	None.......	26.0	35.9	....	....	....	(1.11)
1904	None.......	21.5	....	17.5	55.3	....	....
1904	MLP.......	17.1	....	25.3	72.7	....	....
1905	None.......	24.8	50.0	....	....	42.3	....
1905	MLP.......	31.4	44.9	....	....	50.6	....
1906	None.......	27.1	....	34.7	....	....	(1.42)[1]
1906	MLP.......	35.8	....	52.4	....	....	(1.74)[1]
1907	None.......	29.0	47.8	....	80.5	....	....
1907	MLP.......	48.7	87.6	....	93.6	....	....
1908	None.......	13.4	....	32.9	....	40.0	....
1908	MLP.......	28.0	....	45.0	....	44.4	....
1909	None.......	26.6	33.0	....	....	....	(.65)[2]
1909	MLP.......	31.6	64.8	....	....	....	(1.73)[3]
1910	None.......	35.9	....	33.8	58.6	....	....
1910	MLP.......	54.6	....	59.4	83.3	....	....
1911	None.......	21.9	28.6	....	....	20.6	....
1911	MLP.......	31.5	46.3	....	....	38.0	....
1912	None.......	43.2	....	55.0	....	....	16.3[1]
1912	MLP.......	64.2	....	81.0	....	....	20.0[1]
1913	None.......	19.4	29.2	....	33.8	....	....
1913	MLP.......	32.0	25.0	....	47.8	....	....
1914	None.......	31.6	....	33.6	....	39.6	....
1914	MLP.......	39.4	....	58.2	....	60.4	....
1915	None.......	40.0	49.0	....	....	....	24.2[1]
1915	MLP.......	66.0	81.2	....	....	....	27.1[1]
1916	None.......	11.2	....	37.5	27.8	....	....
1916	MLP.......	10.8	....	64.7	40.6	....	....
1917	None.......	40.0	48.4	....	....	68.4	....
1917	MLP.......	78.0	81.4	....	....	86.9	....
1918	None.......	13.6	....	27.2	....	....	(2.58)
1918	MLP.......	32.6	....	59.3	....	....	(4.04)
1919	None.......	24.0	30.8	....	52.2	....	....
1919	MLP.......	43.4	66.2	....	70.8	....	....
1920	None.......	28.2	....	37.2	....	52.2	....
1920	MLP.......	54.4	....	51.6	....	69.7	....

[1]Soybeans.
[2]In addition to the hay, .64 bushel of seed was harvested.
[3]In addition to the hay, 1.17 bushels of seed were harvested.

TABLE 2.—URBANA FIELD, MORROW PLOTS: GENERAL SUMMARY

Bushels or (tons) per acre

Years	Soil treatment applied	Corn every year	Two-year rotation		Three-year rotation		
			Corn	Oats	Corn	Oats	Clover
		16 crops	*9 crops*	*6 crops*	*4 crops*	*4 crops*	*4 crops*
1888 to 1903	None.......	39.7	41.0	44.0	48.0	47.6	(2.03)
		17 crops	*8 crops*	*9 crops*	*6 crops*	*6 crops*	*3 crops*
1904 to 1920	None.......	26.6	39.6	34.4	51.4	43.9	(1.55)[1]
	MLP.......	41.1	62.2	55.2	68.1	58.3	(2.50)[1]

[1]One crop of soybean hay.

The Morrow series now consists of three plots divided into halves and the halves are subdivided into quarters. On one plot corn is grown continuously; on the second corn and oats are grown in rotation; and on the third, corn, oats, and clover are rotated. The north half of each plot has had no fertilizing material applied from the beginning of the experiments, while the south half has been treated since 1904, receiving standard applications of farm manure with cover crops grown in the one-crop and two-crop systems. Phosphorus has been applied in two different forms: rock phosphate to the southwest quarter at the rate of 600 pounds, and steamed bone meal to the southeast quarter at the rate of 200 pounds per acre per year up to 1919, when the rock phosphate was increased sufficiently to bring up the total amount applied to four times the quantity of bone meal applied. At the same time the rate of subsequent application of both forms of phosphorus was reduced to one-fourth the quantity, or to 200 pounds of rock phosphate and 50 pounds of bone meal per acre per year. In 1904 ground limestone was applied at the rate of 1,700 pounds per acre to the south half of each plot, and in 1918 a further application was made at the rate of 5 tons per acre with the intention of standardizing the application to the rate of 1,000 pounds of limestone per acre per year.

FIG. 1.—CORN ON THE MORROW PLOTS IN 1910

Table 1 gives the yearly records of the crop yields, and Table 2 presents the same in summarized form.

Summarizing the data from these Morrow plots into two periods with the second period beginning in 1904 when the treatment began on the half-plots, some interesting comparisons may be made. In the first place we find in the continuous corn plot a marked decrease in the second period in the average yield of corn, amounting to one-third of the crop. In the two-year rotation there is a decrease in both corn and oats production, while the averages for the three-year system show an increase in corn yield and decreases in oats and clover. Unfortunately the numbers of crops included in these last averages are too small to warrant positive conclusions.

The increase brought about by soil treatment stands out in all cases, showing the possibility not only of restoring but also of greatly improving the productive power of this land that has been so abused by continuous cropping without fertilization.

The Davenport Plots

Another set of plots on the University campus at Urbana, forming a more extensive series than the Morrow plots, but of more recent origin, are the Davenport plots. Here each crop in the rotation is represented every year. These plots were laid out in 1895, but special soil treatment was not begun until 1901. They now comprize five series of ten plots each, and each series constitutes a "field" in a crop rotation system.

From 1901 to 1911 three of the series were in a three-year rotation system of corn, oats, and clover, while the remaining two series rotated in corn and oats. In 1911 these two systems were combined into a five-series field, with a crop rotation of wheat, corn, oats, and clover, with alfalfa on a fifth field. The alfalfa occupies one series during a rotation of the other four crops, shifting to another series in the fifth year, thus completing the cycle of all series in twenty-five years.

The soil treatment applied to these plots has been as follows:

Legume cover crops were seeded in the corn at the last cultivation on Plots 2, 4, 6, and 8, from 1902 to 1907, but the growth was small and the effect, if any, was to decrease the returns from the regular crops. Crop residues (**R**) have been returned to these same plots since 1907. These consist of stalks and straw, and all legumes except alfalfa hay and the seed of clover and soybeans. Beginning in 1918 a modification of the practice was made in that one cutting of the red clover crop is harvested as hay. In conjunction with these residues a catch crop of sweet clover grown with the wheat is plowed under.

Manure (**M**) was applied preceding corn, at the rate of 2 tons per acre per year in 1905, 1906, and 1907; subsequently as many tons have been applied as there have been tons of air-dry produce harvested from the respective plots.

Lime (**L**) was applied on Plots 4 to 10 at the rate per acre of 250 pounds of air-slaked lime in 1902, and 600 pounds of limestone in 1903. No further application was made until 1911, when the system of cropping was changed. Since that time applications of limestone have been made at the rate of one-half ton per acre per year.

Phosphorus (**P**) was applied on Plots 6 to 9 at the rate of 25 pounds per acre per annum in 200 pounds of steamed bone meal; but beginning with 1908 rock phosphate at the rate of 600 pounds per acre per annum was substi-

TABLE 3.—URBANA FIELD, DAVENPORT PLOTS: BROWN SILT LOAM, PRAIRIE; EARLY WISCONSIN GLACIATION

Ten-Year Average Annual Yields—Bushels or (tons) per acre
1911-1920

Serial plot No.	Soil treatment applied	Corn	Oats	Wheat	Clover 5 crops	Soybeans 5 crops	Alfalfa
1	0	55.6	50.5	26.0	(2.42)	(1.47)	(2.43)
2	R	57.1	52.3	28.7	1.47[1]	19.8	(2.46)
3	M	66.3	61.9	28.2	(2.56)	(1.62)	(2.52)
4	RL	64.8	55.6	31.4	1.61[1]	20.3	(2.72)
5	ML	69.6	64.1	32.8	(2.90)	(1.67)	(3.03)
6	RLP	71.5	69.8	43.0	2.29[1]	23.5	(3.69)
7	MLP	73.0	68.6	40.0	(3.52)	(1.97)	(3.76)
8	RLPK	70.9	72.5	40.7	1.79[1]	25.5	(3.77)
9	MLPK	70.2	72.0	39.2	(3.40)	(2.20)	(3.73)
10	Mx5LPx5	65.9	71.4	40.6	(3.31)	(2.22)	(3.77)

[1]In addition to the clover seed, a crop of hay was harvested one year on Plots 2, 4, 6, and 8, yielding 2.38, 2.20, 2.54, and 2.39 tons, respectively.

tuted for the bone meal on one-half of each of these plots. These applications continued until 1918 when adjustments were begun, first to make the rate of application of rock phosphate four times that of the bone meal, and finally to reduce the amounts of these materials to 200 pounds of rock phosphate and 50 pounds of bone meal per acre per annum. The usual practice has been to apply and plow under at one time all phosphorus and potassium required for the rotation.

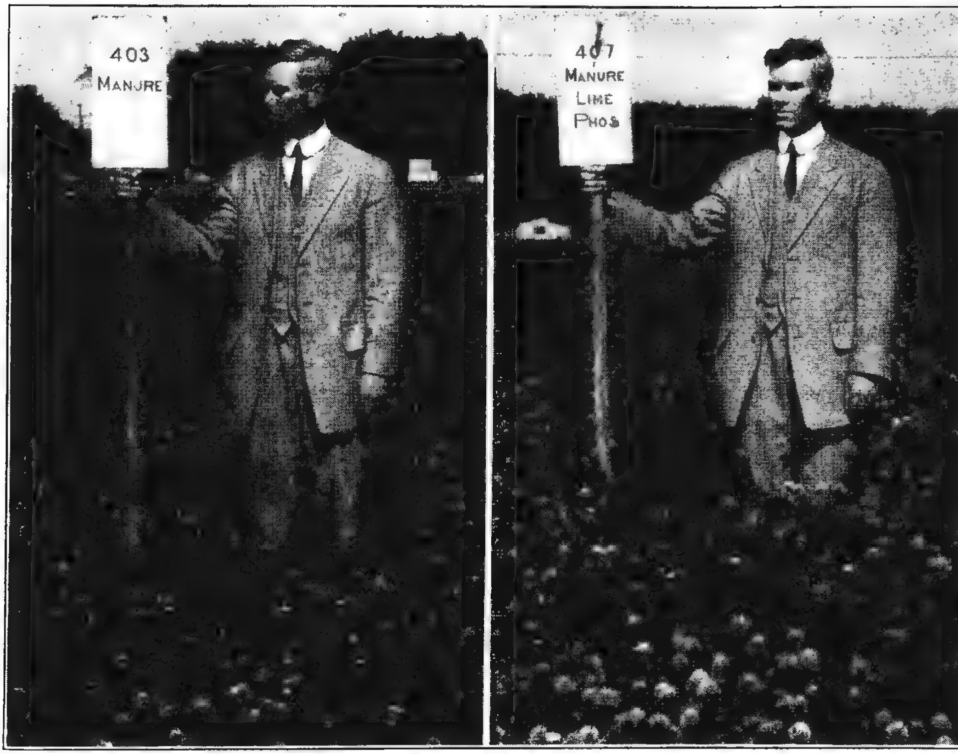
Potassium (**K** = kalium) has been applied on Plots 8 and 9 in connection with the bone meal and rock phosphate, at the yearly rate of 42 pounds per acre, and mainly as potassium sulfate.

On Plot 10 about five times as much manure and phosphorus are applied as on the other plots, but this "extra heavy" treatment was not begun until 1906, only the usual lime, phosphorus, and potassium having been applied in previous years. The purpose in making these heavy applications is to try to determine the climatic possibilities in crop yields by removing the limitations of inadequate fertility.

It will be observed that the applications described above provide for the two rather distinct systems of farming already described. *The grain system,* in which animal manure is not produced and where the organic matter is provided by the direct return to the soil of all crop residues, is exemplified in Plots 2, 4, 6, and 8; and the *live-stock system,* in which farm manure is utilized for soil enrichment, is represented in Plots 3, 5, 7, and 9.

Table 3 shows a summary of the results obtained on the Davenport plots beginning with the year 1911, when the present cropping system was introduced.

When used in conjunction with phosphorus the crop residues and the manure appear about equally effective; but where phosphorus is not applied, the manure has been decidedly more effective, under the conditions of the experiment. It should be observed, however, in this connection, that the plowing under of clover is a very essential feature of the residues system, and that, as a matter of fact, there were five clover failures, when soybeans were substituted, during the ten years. Perhaps with a more reliable biennial legume than red clover, the results would have been more favorable for this system.



Manure
Yield: 1.43 tons per acre

Manure, limestone, phosphorus
Yield: 2.90 tons per acre

FIG. 2.—CLOVER ON THE DAVENPORT PLOTS IN 1913

By comparing Plots 2 and 3 with Plots 4 and 5, it is found that limestone has had a beneficial effect on all crops. What the financial profit amounts to depends obviously upon the market value of the crops and the cost of the limestone.

Comparing Plots 4 and 5 with Plots 6 and 7, respectively, there is found in all cases an increase in crop yield as a result of adding phosphorus. The effect on wheat is especially pronounced. Where limestone and phosphorus are applied in addition to the crop residues, an increase of 17 bushels of wheat, over the yield of the untreated land, has been obtained as a ten-year average.

The effect of adding potassium to the treatment is of much interest. Plots 8 and 9 are the same as Plots 6 and 7, respectively, except that potassium has been applied to the former. On the whole, no significant benefit is shown from the addition of potassium.

No benefit appears as the result of the extra-heavy applications of manure and phosphorus on Plot 10. In fact the corn yields are noticeably less here than on the plots receiving the normal applications of these materials.

The University South Farm

On the University South Farm, at Urbana, several series of plots devoted primarily to variety testing and other crop-production experiments are so laid out as to show the effects of certain soil treatments that have been applied.

Several different systems of crop rotation are employed and the crops are so handled as to exemplify the two general systems of farming, grain and livestock.

The summarized results presented in Table 4 represent three different systems of cropping. The first, designated as the Southwest rotation, is to be regarded as a good rotation for general practice, on this type of soil, under Illinois conditions. This is a four-field rotation of wheat, corn, oats, and clover. The second, or North-Central rotation, consisting of corn, corn, oats, and clover, represents a system very commonly practiced; and the third or South-Central rotation, consisting of corn, corn, corn, and soybeans, must be considered as a poor rotation from the standpoint of maintaining the productiveness of the land.

TABLE 4.—URBANA FIELD, SOUTH FARM: BROWN SILT LOAM, PRAIRIE; EARLY WISCONSIN GLACIATION

Average Annual Yields—Bushels or (tons) per acre

Southwest Rotation: Series 100, 200, 400[1]: Wheat, Corn, Oats, Clover[2]

Soil treatment applied[6]	Corn 9 crops	Oats[3] 9 crops	Wheat[3] 8 crops	Clover[4] 3 crops	Soybeans 7 crops
RP	62.3	51.9	41.0	1.05	17.3[5]
R	51.9	46.5	26.9	1.38	16.2[5]
M	59.7	50.2	29.1	(2.28)	(1.25)
MP	64.3	55.4	43.1	(2.86)	(1.51)
RLP	60.5	57.2	41.8	.64	16.4[5]
R	49.7	49.6	25.8	.83	14.7[5]
M	55.5	54.1	27.8	(1.71)	(1.28)
MLP	64.1	59.6	43.9	(1.77)	(1.58)

North-Central Rotation: Series 500, 600, 700[1]: Corn, Corn, Oats, Clover[2]

Soil treatment applied[6]	Corn 1st year 9 crops	Corn 2d year 9 crops	Oats 9 crops	Clover 5 crops	Soybeans 4 crops
RP	56.7	51.1	56.1	.54	16.9
R	51.7	45.2	52.0	.50	16.0
M	54.9	46.7	52.1	(2.29)	(1.60)
MP	56.5	53.4	56.9	(2.73)	(1.74)

South-Central Rotation: Series 500, 600, 700[1]: Corn, Corn, Corn, Soybeans

Soil treatment applied[6]	Corn 1st year 9 crops	Corn 2d year 9 crops	Corn 3d year 9 crops		Soybeans 9 crops
RP	51.9	44.0	41.3		20.0
R	45.5	39.9	35.2		19.2
M	50.1	42.1	33.5		(1.59)
MP	54.5	46.7	42.0		(1.66)

[1]Results from Series 300 and 800 are omitted on account of variation in soil type.
[2]Soybeans when clover fails.
[3]Only seven crops with limestone.
[4]Only one crop with limestone.
[5]Average of five crops.
[6]All phosphorus plots received ½ ton per acre of limestone in 1903.

TABLE 5.—COMPARING PRODUCTION OF CORN IN THREE DIFFERENT ROTATION SYSTEMS
ACRE YIELDS FROM PLOTS ON THE UNIVERSITY SOUTH FARM
Twelve-Year Average (1908-1919)—Bushels per acre

Rotation	Wheat-corn-oats-legume[1]	Corn-corn-oats-legume[2]		Corn-corn-corn-legume[3]		
Treatment	Corn	1st Corn	2d Corn	1st Corn	2d Corn	3d Corn
Organic manures	55.8	53.3	46.0	47.8	41.0	34.3
Organic manures, phosphorus	63.2	56.6	52.3	53.2	45.3	41.6

[1]Clover 3 crops, and soybeans 7 crops.
[2]Clover 5 crops, and soybeans 5 crops.
[3]Soybeans 9 crops.

On the whole, the "residues" have not returned yields quite so high as those produced by the manure treatment; but, as remarked above in the discussion of the Davenport plots, the residues system has probably been at a disadvantage thru frequent clover failures. On the North-Central rotation, where conditions seem to have been more favorable for clover, there is very little difference between the effect of manure and of residues.

Residues plowed under
Yield: 35.2 bushels per acre

Residues and rock phosphate
Yield: 50.1 bushels per acre

FIG. 3.—WHEAT ON THE UNIVERSITY SOUTH FARM IN 1911

In the rotation system in which limestone is being applied, no benefit of consequence to any of the crops except oats appears from the use of this material. The test, however, has hardly been of sufficient duration to warrant final conclusions; and furthermore, the comparison may be somewhat impaired by a possible residual effect of the small application of limestone made in 1903 to all the phosphorus plots.

The results obtained from the use of phosphorus are important because this element has been applied to these plots solely in the form of raw rock phosphate. The figures in almost every case show an increase in yield where the phosphorus has been applied, and in most cases this increase is very pronounced. The wheat is especially responsive to phosphorus.

The records furnish some interesting comparisons of corn yields produced under different systems of cropping. Table 5 gives a general summary of the corn yields only, in which the results from the residues and manure treatments are averaged together as "organic manures." The highest annual acre-yields are found where corn occurs but once in a rotation. Where corn is grown twice in succession, the annual acre-yields are less; and where corn occurs three times, there is a further reduction. Also, the first crop of corn within a rotation produces more than the second, and the second crop yields more than the third. These are useful facts for consideration in connection with problems of general farm management.

BLACK CLAY LOAM

The Hartsburg experiment field, representing black clay loam of the middle Illinoisan glaciation, is located in Logan county just east of Hartsburg. The work was begun here in 1913. There are five series of ten plots each. A crop rotation of wheat, corn, oats, and clover, with alfalfa on a fifth field, is practiced. The soil treatments are as indicated in Table 6. The table also summarizes the

TABLE 6.—HARTSBURG FIELD: BLACK CLAY LOAM, PRAIRIE; MIDDLE ILLINOISAN GLACIATION

Average Annual Yields—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Wheat 5 crops	Corn 8 crops	Oats 7 crops	Clover 4 crops	Soybeans 2 crops	Alfalfa 8 crops[1]
1	0	22.6	43.4	45.4	(1.98)	(1.29)	(3.30)
2	M	27.4	48.3	50.2	(2.41)	(1.64)	(3.61)
3	ML	34.2	56.9	57.9	(2.51)	(1.82)	(3.83)
4	MLP	38.2	56.0	57.3	(2.62)	(1.92)	(4.04)
5	0	33.3	46.8	43.8	.74[2]	25.8	(3.19)
6	R	34.0	58.2	55.6	1.22[2]	26.8	(3.60)
7	RL	32.0	63.7	54.9	1.32[2]	28.4	(3.28)
8	RLP	36.4	61.1	59.0	1.41[2]	26.1	(3.83)
9	RLPK	35.2	59.5	57.2	1.42[2]	26.4	(4.01)
10	0	31.7	46.7	46.9	(2.14)	(1.69)	(3.02)

[1]No residues except on last two crops.
[2]In addition to the clover seed, hay was harvested on Plots 5, 6, 7, 8, and 9 amounting to .56, 1.01, 1.11, 1.20, and 1.03 tons, respectively.

yields, by crops, for the period during which the plots have been under full treatment.

Under the conditions of these experiments, residues alone have proved to be more effective than manure alone in the production of wheat, corn, and oats.

Limestone used with manure has given such greatly increased yields as to leave no doubt about the profitableness of its use. When applied with residues, however, there appears to be on the whole little advantage from the use of limestone.

Phosphorus has given good returns on the wheat crop, but with the other crops its recommendation would be doubtful. In this connection attention should be called to the fact that chemical analysis of this black clay loam type generally shows a relatively high phosphorus content. The experience on this field seems to bear out what the analyses show.

The addition of potassium has produced a depressing effect on the yields of all grain crops, and with the alfalfa the small gain could scarcely be considered significant.

YELLOW-GRAY SILT LOAM

Yellow-gray silt loam exhibits an important variation with respect to limestone content. In some areas, altho limestone may be altogether absent in the surface stratum it is found in abundance at a short distance beneath the surface. Accordingly, variations in response to soil treatment are exhibited by different experiment fields located on this type. In view of this discrepancy it is thought well to introduce here the records of two fields, that are representative of the type but which show a marked diversity in results, one in northern Illinois and one in the southern part of the state.

The Antioch field is located on the late Wisconsin glaciation, in Lake county, close to the Wisconsin border. The field was started in 1902, with but a single series of ten plots, under a rotation of corn, corn, oats, and wheat; but beginning with 1911 the rotation has been wheat, corn, oats, and clover. It was started in order to learn as quickly as possible what effect would be produced by the addition to this type of soil of nitrogen, phosphorus, and potassium, used singly and in combination. These elements were all applied in commercial form until 1911, after which the use of commercial nitrogen was discontinued and crop residues were substituted in its place. Nitrogen was supplied in the earlier years in 800 pounds per acre of dried blood. Phosphorus is applied in 200 pounds of steamed bone meal, and potassium in 100 pounds of potassium sulfate. At the beginning, 470 pounds of slaked lime was applied; but since 1912 limestone has been applied at the rate of 1,000 pounds per acre per year.

Table 7 presents, in summarized form, the results from the Antioch field. Because of an abnormality in Plot 1, the results from this plot are not considered. The data show that phosphorus is the one element standing out prominently as producing consistently beneficial results. Potassium applied in addition to phosphorus has, on the whole, not produced profitable results. Also, the results are unfavorable for the application of limestone. Limestone, however, is abundant in the subsoil of this type in the region of this field.

Lime applied and residues plowed under

Lime and phosphorus applied

FIG. 4.—CLOVER IN 1913 ON ANTIOCH FIELD

TABLE 7.—ANTIOCH FIELD: YELLOW-GRAY SILT LOAM, TIMBER SOIL; LATE WISCONSIN GLACIATION

Average Annual Yields—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn 8 crops	Oats 5 crops	Wheat 4 crops	Clover seed 2 crops
1	0	23.9	32.3	15.8	.50
2	L	21.3	26.8	13.2	.30
3	LR	21.3	29.9	20.6	.33
4	LP	30.7	43.6	36.7	1.08
5	LK	23.7	27.8	19.2	.57
6	LRP	33.8	43.3	33.3	.57
7	LRK	24.3	26.9	20.8	.59
8	LPK	25.1	38.2	30.9	1.26
9	LRPK	38.3	42.6	28.0	.33
10	RPK	38.4	44.7	30.2	.67

The Raleigh experiment field is located on the lower Illinoisan glaciation, in southern Illinois, in Saline county. This field is laid out into four series of ten plots each, under a rotation of wheat, corn, oats, and clover. The treatments, along with the summarized results, are given in Table 8.

The outstanding feature of these results is the effect of limestone. Altho manure alone produces a substantial increase, especially in the corn crop, when limestone is added a remarkable increase is found in all crops. A most important fact is that the organic matter can be effectively built up thru the use

Manure, limestone, phosphorus
Yield: 61 bushels per acre

Nothing applied
Yield: 15 bushels per acre

FIG. 5.—CORN ON RALEIGH FIELD IN 1920

TABLE 8.—RALEIGH FIELD: YELLOW-GRAY SILT LOAM, TIMBER SOIL; LOWER ILLINOISAN GLACIATION

Average Annual Yields—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn 10 crops	Oats 10 crops	Wheat 6 crops	Clover 4 crops		Soybeans 4 crops
1	0	17.3	10.4	5.8	(.26)		(.65)
2	M	29.7	13.0	7.7	(.31)		(.81)
3	ML	40.9	20.0	21.0	(1.08)		(1.08)
4	MLP	41.2	20.3	21.5	(1.32)		(1.24)
5	0	17.3	10.3	7.0	(.00)	.01[2]	2.3
6	R	20.1	12.8	8.4	(.00)	.01[2]	3.0
7	RL	34.9	21.5	18.8	(1.60)[1]	.10[2]	5.8
8	RLP	36.5	22.7	21.2	(1.61)[1]	.09[2]	6.8
9	RLPK	41.9	23.6	22.4	(1.79)[1]	.12[2]	6.0
10	0	19.6	11.6	6.5	(1.06)		(.57)

[1]One crop only (1920).
[2]Average of two crops.

of crop residues, with the application of limestone, so that the crop yields are practically as high under this "grain system" of farming as where manure is used.

Phosphorus thus far has given only moderate returns in increased crop yields, but with an increasing quantity of organic matter and nitrogen it is probable that the phosphorus applications will show up more favorably on sub-

sequent crops. As to the use of potassium, it is to be noted that aside from an increase of 5.4 bushels of corn in the residues system, the beneficial effect has not been sufficient to justify the use of this material.

In accounting for the discrepancy in the response to limestone on these two fields, the fact is to be considered that the Antioch field is located on the late Wisconsin glaciation, where the subsoil contains large quantities of limestone; while the Raleigh field represents the lower Illinoisan glaciation, the soil of which is very acid to a great depth.

In view of these variations, a general recommendation for a complete treatment for soil of this type, that will apply to all localities, cannot be given out until more information is acquired.

Fortunately, however, each farmer can determine for himself the need of limestone for his land by applying the simple tests for the presence of carbonates and soil acidity, as explained under the discussion of limestone on page 36 of the Appendix.

Phosphorus, which has paid well on the Antioch field, and has given doubtful returns thus far at Raleigh, has varied considerably in its effect when used on other fields located on this same type of soil. In this situation, therefore, the present suggestion would be that each farmer might well try out phosphorus on his own land, on a limited scale, and be guided by the outcome of his experience. The low phosphorus content of the surface stratum of this soil is an indication that in a system of permanent agriculture the time is not far off when phosphorus will become a limiting element to crop production, and the wise farmer will watch carefully the indications and be ready to make timely provision for this need.

DUNE SAND

In 1913 the University came into possession of a tract of dune sand on terrace, in Henderson county, near the Mississippi river, upon which an experiment field was laid out to determine the needs of these sand soils. This field is divided into six series of plots. Corn, soybeans, wheat, sweet clover, and rye, with a catch crop of sweet clover seeded in the rye on the residues plots, are grown in rotation on five series, while the sixth series is devoted to alfalfa. When sweet clover seeded in the wheat fails, cowpeas are substituted.

No catch of alfalfa or of sweet clover was obtained till the alfalfa drill was used in seeding. This covers the seed about one-half inch deep.

Table 9 indicates the kinds of treatment applied, the amounts of the materials used being in accord with the standard practice, as explained on page 46.

The data make apparent the remarkably beneficial action of limestone on this sand soil. Where limestone has been used in conjunction with crop residues, the yield of corn has been doubled. The limestone has also produced a fair crop of rye and excellent crops of sweet clover and alfalfa.

This land appears to be quite indifferent to phosphorus treatment. The analysis shows, however, that the stock of phosphorus in this type of soil is not large, and it may develop as time goes on and the supply diminishes along with the production of good-sized crops, that the application of this element will become profitable.

Manure
Yield: Nothing

Manure and limestone
Yield: 4.43 tons per acre

FIG. 6.—ALFALFA ON OQUAWKA FIELD IN 1918

TABLE 9.—OQUAWKA FIELD: DUNE SAND, TERRACE
Average Annual Yields—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn 6 crops	Soy-beans[1] 5 crops	Wheat 6 crops	Sweet clover 4 crops	Rye 4 crops	Alfalfa 3 crops
1	0	14.3	(.89)	6.4	0	12.1	(.11)
2	M	18.9	(1.01)	8.1	0	13.3	(.13)
3	ML	23.4	(1.27)	9.7	(1.20)	20.1	(1.88)
4	MLP	22.2	(1.20)	10.1	(1.26)	19.5	(2.03)
					2 crops 2 crops		
5	0	14.4	3.5	7.4	(0) 0	13.7	(.14)
6	R	16.2	3.5	8.1	(0) 0	14.1	(.12)
7	RL	29.3	6.6	9.1	(1.47) 2.53	23.2	(2.05)
8	RLP	29.3	6.4	10.4	(1.39) 2.20	24.2	(1.90)
9	RLPK	32.7	6.0	9.4	(1.53) 2.84	23.7	(1.86)
10	0	11.4	(.60)	6.4	(0)	10.6	(.06)

[1] In 1918 sweet clover was killed by being cut for hay. Soybeans were seeded on these plots and the following yields obtained: .86, 1.10, 1.93, and 2.00 tons of hay per acre on Plots 1 to 4; 11.1, 9.9, 14.6, 15.8, and 16.6 bushels of seed per acre on Plots 5 to 9; and .62 ton of hay per acre on Plot 10.

Altho the results show an increase of 3.4 bushels of corn from the use of potassium salts, with ordinary prices this would not be a profitable treatment. The .64 bushel gain in sweet-clover seed is the average of two crops only, and this is insufficient data upon which to base conclusions. The other crops all show negative results from the potassium application.

Experience thus far shows rye to be better adapted to this land than wheat, and both alfalfa and sweet clover thrive better than soybeans. With these two legume crops thriving so well under this simple treatment, we have promise of tremendous possibilities for the profitable culture of this land, which hitherto has been considered as practically worthless.

Deep Peat

As representing the deep peat type of soil, the results are introduced from an experiment field conducted at Manito in Mason county during the years 1902 to 1905 inclusive.

The results of the four years' tests, as given in Table 10, are in complete harmony with the information furnished by the chemical composition of peat soil. Where potassium was applied, the yield was from three to four times as large as where nothing was applied. Where approximately equal money values of kainit and potassium chlorid were applied, slightly greater yields were obtained with the potassium chlorid, which, however, supplied about one-third more potassium than the kainit. On the other hand, either material furnished more potassium than was required by the crops produced.

The use of 700 pounds of sodium chlorid (common salt) produced no appreciable increase over the best untreated plots, indicating that where potassium is itself actually deficient, salts of other elements cannot take its place.

Applications of 2 tons per acre of ground limestone produced no increase in the corn crops, either when applied alone or in combination with kainit, either the first year or the second.

Reducing the application of kainit from 600 to 300 pounds for each two-year period reduced the yield of corn from 164.5 to 125.9 bushels. The two applications of 300 pounds of kainit (Plot 9) furnished 60 pounds of potassium for the four years, an amount sufficient for 84 bushels of corn (grain and stalks). Attention is called to the fact that this is practically the difference between the yield of Plot 9 (125.9 bushels) and the yield obtained from Plot 2 (42.9 bushels), the poorest untreated plot.

TABLE 10.—MANITO FIELD: DEEP PEAT

Corn Yields—Bushels

Plot No.	Soil treatment for 1902	Corn 1902	Corn 1903	Soil treatment for 1904	Corn 1904	Corn 1905	Four crops
1	None	10.9	8.1	None	17.0	12.0	48.0
2	None	10.4	10.4	Limestone, 4000 lbs.	12.0	10.1	42.9
3	Kainit, 600 lbs	30.4	32.4	Limestone, 4000 lbs.; Kainit, 1200 lbs.	49.6	47.3	159.7
4	Kainit, 600 lbs.; Acidulat'd bone, 350 lb.	30.3	33.3	Kainit, 1200 lbs.; Steamed bone, 395 lbs.	53.5	47.6	164.7
5	Potassium chlorid, 200 lbs.	31.2	33.9	Potassium chlorid, 400 lbs.	48.5	52.7	166.3
6	Sodium chlorid, 700 lbs.	11.1	13.1	None	24.0	22.1	70.3
7	Sodium chlorid, 700 lbs.	13.3	14.5	Kainit, 1200 lbs.	44.5	47.3	......
8	Kainit, 600 lbs.	36.8	37.7	Kainit, 600 lbs.	44.0	46.0	164.5
9	Kainit, 300 lbs.	26.4	25.1	Kainit, 300 lbs.	41.5	32.9	125.9
10	None	14.9[1]	14.9	None	26.0	13.6	69.4

[1]Estimated from 1903; no yield was taken in 1902 because of a misunderstanding.

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

LEGEND

900 Early Wisconsin Moraines

1000 Late Wisconsin Moraines

1100 Early Wisconsin Intermorainal Areas

1200 Late Wisconsin Intermorainal Areas

(a) UPLAND PRAIRIE SOILS

26	Brown silt loam
20	Black clay loam
60	Brown sandy loam
81	Dune sand
28 / 1128	Brown-gray silt loam on tight clay
28.1 / 1128.1	Brown silt loam on tight clay

(b) UPLAND TIMBER SOILS

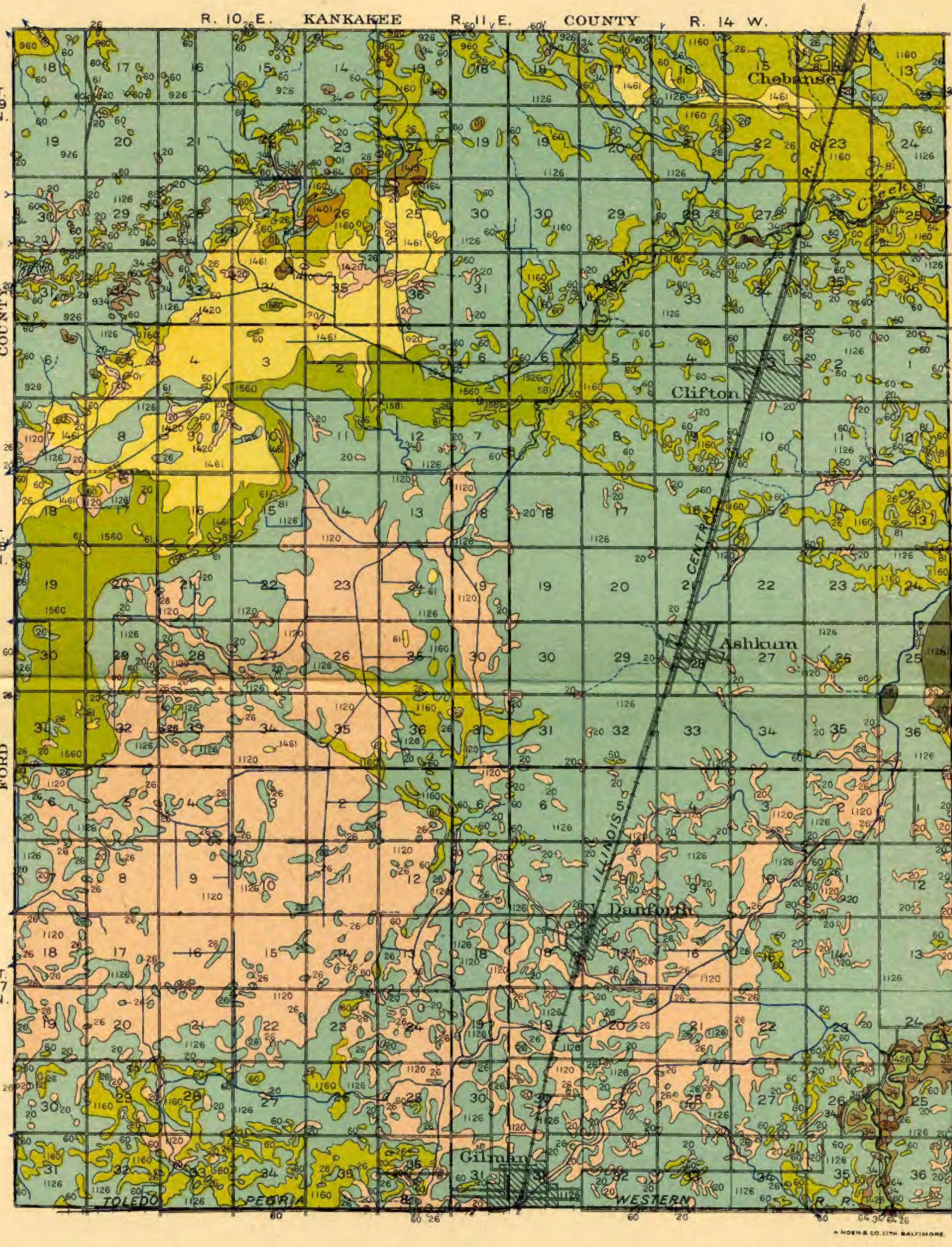
34	Yellow-gray silt loam
64	Yellow-gray sandy loam
35	Yellow silt loam
38	Yellow-gray silt loam on tight clay

(c) 1500 TERRACE SOILS

1560	Brown sandy loam
1526	Brown silt loam
27 / 1527	Brown silt loam over gravel
1564	Yellow-gray sandy loam
81 / 1581	Dune sand
Z / 1534	Yellow-gray silt loam
36 / 1536	Yellow-gray silt loam over gravel
1566	Brown sandy loam over gravel
67 / 1567	Yellow-gray sandy loam over gravel
26.4 / 1526.4	Brown silt loam on gravel
1520	Black clay loam

(d) 1400 SWAMP AND BOTTOM-LAND SOILS

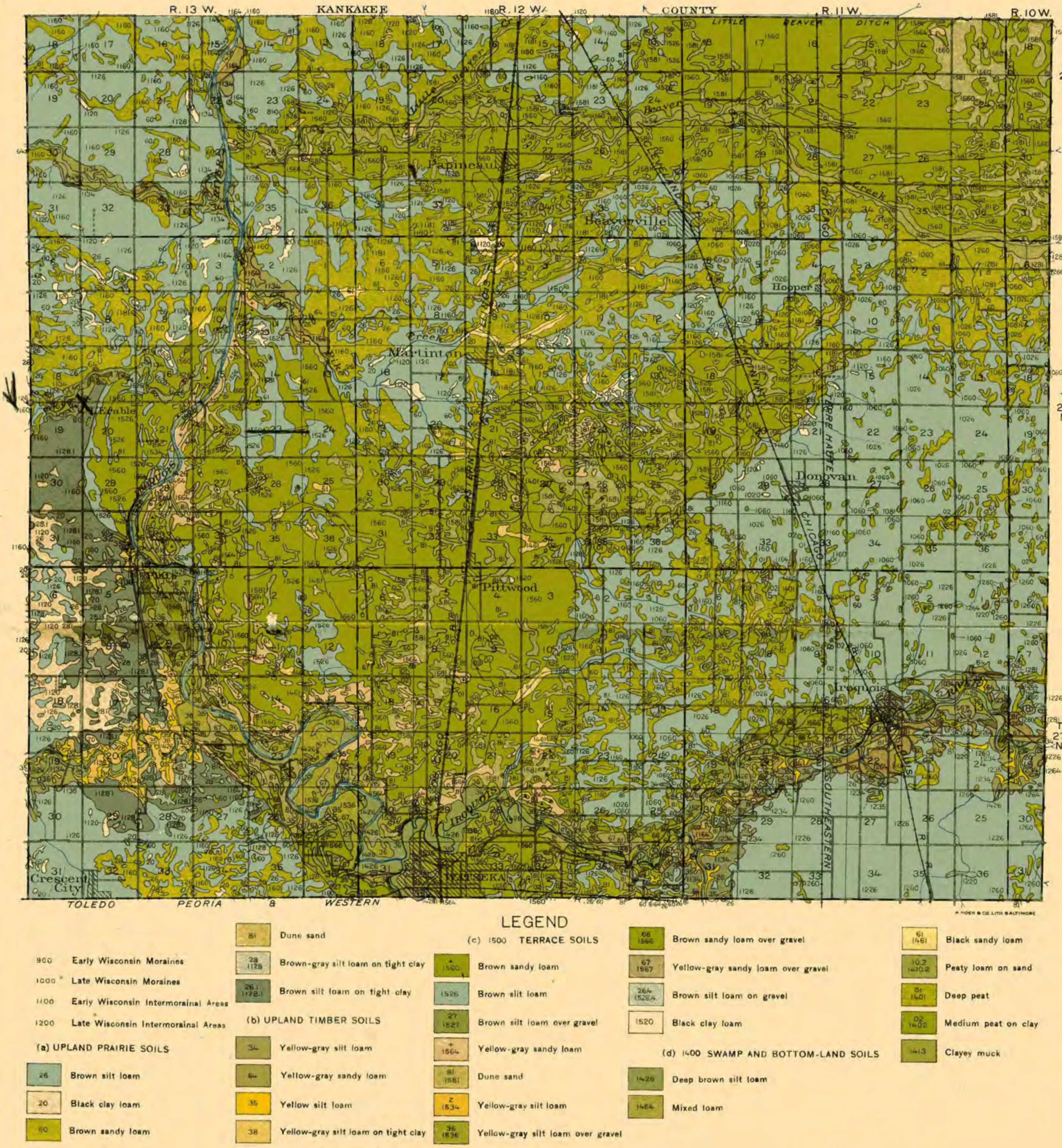
1426	Deep brown silt loam
1454	Mixed loam
61 / 1461	Black sandy loam
10.2 / 1410.2	Peaty loam on sand
01 / 1401	Deep peat
02 / 1402	Medium peat on clay
1413	Clayey muck
20	Black clay loam



A. HOEN & CO. LITH. BALTIMORE.

SOIL SURVEY MAP OF IROQUOIS COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

Scale
0 ¼ ½ 1 2 Miles



SOIL SURVEY MAP OF IROQUOIS COUNTY

UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

Scale

0 ¼ ½ 1 2 Miles

LEGEND

900 Early Wisconsin Moraines

1000 Late Wisconsin Moraines

1100 Early Wisconsin Intermorainal Areas

1200 Late Wisconsin Intermorainal Areas

(a) UPLAND PRAIRIE SOILS

26	Brown silt loam
20	Black clay loam
60	Brown sandy loam
81	Dune sand
28 / 1128	Brown-gray silt loam on tight clay
281 / 1281	Brown silt loam on tight clay

(b) UPLAND TIMBER SOILS

34	Yellow-gray silt loam
64	Yellow-gray sandy loam
35	Yellow silt loam
38	Yellow-gray silt loam on tight clay

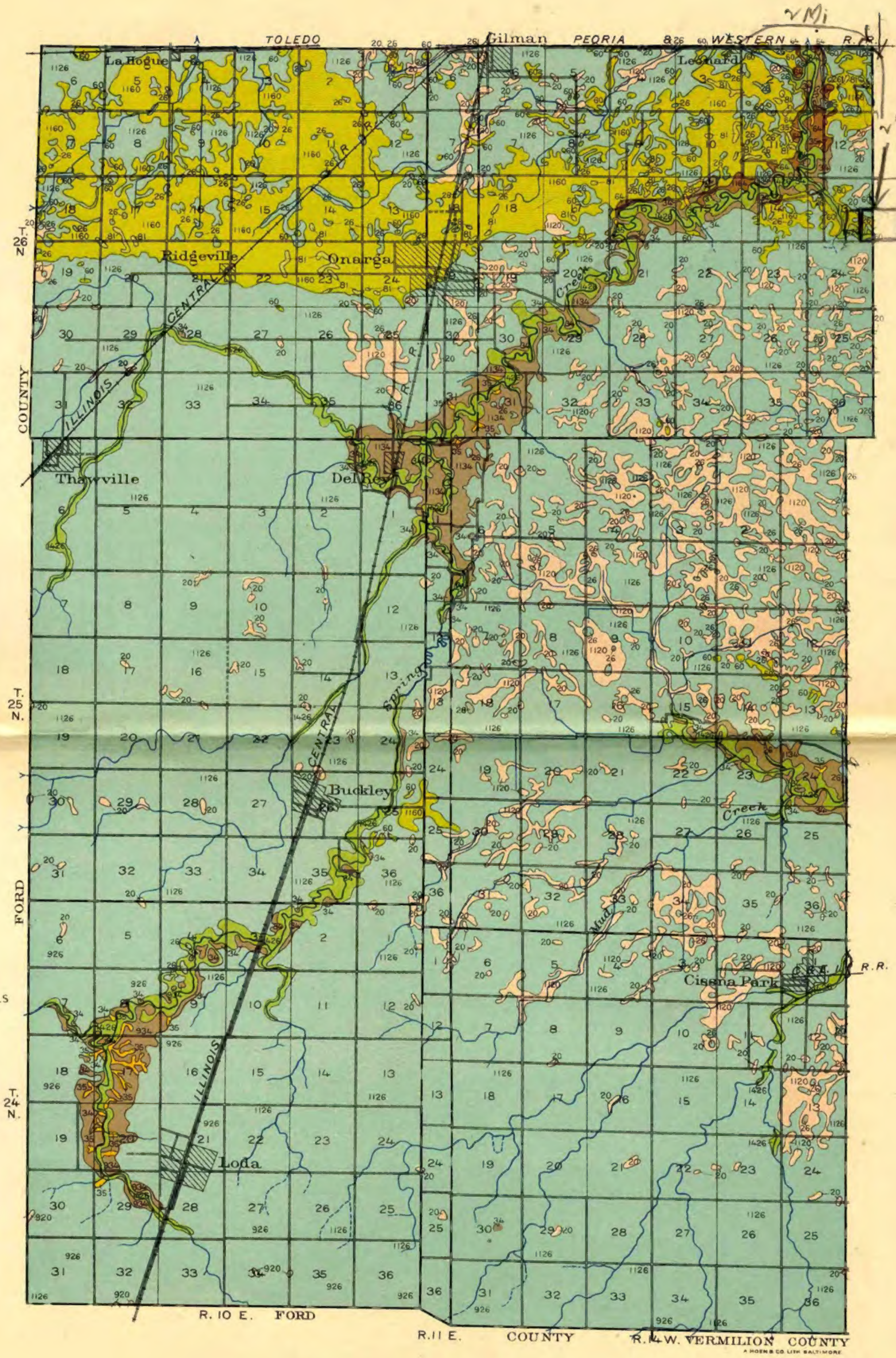
(c) 1500 TERRACE SOILS

1560	Brown sandy loam
1526	Brown silt loam
27 / 1527	Brown silt loam over gravel
1564	Yellow-gray sandy loam
81 / 1581	Dune sand
2 / 1534	Yellow-gray silt loam
36 / 1536	Yellow-gray silt loam over gravel
66 / 1566	Brown sandy loam over gravel
67 / 1567	Yellow-gray sandy loam over gravel
264 / 15264	Brown silt loam on gravel
1520	Black clay loam

(d) 1400 SWAMP AND BOTTOM-LAND SOILS

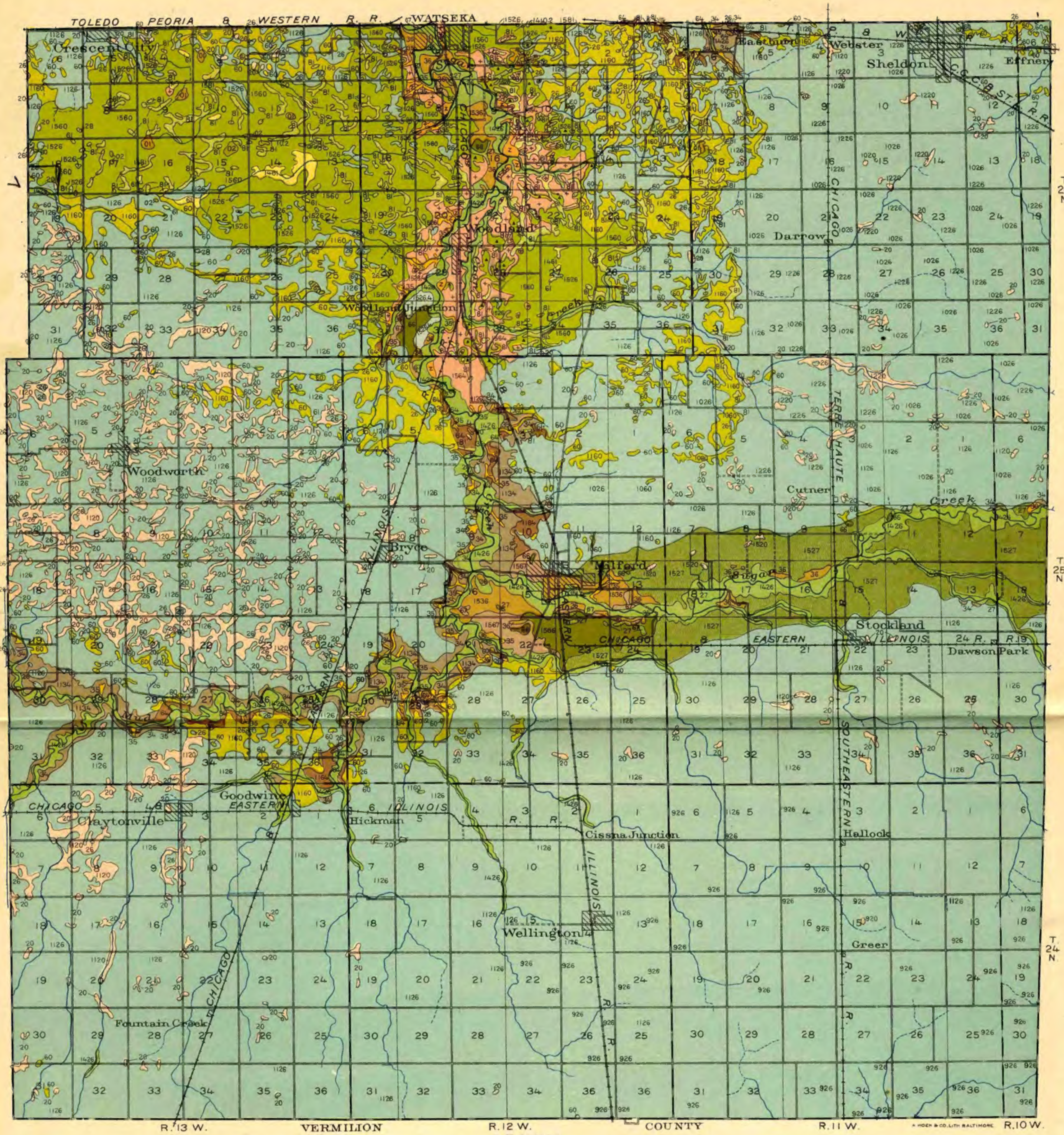
1426	Deep brown silt loam
1484	Mixed loam
61 / 1461	Black sandy loam
10.2 / 1410.2	Peaty loam on sand
01 / 1401	Deep peat
02 / 1402	Medium peat on clay
1413	Clayey muck

Scale
0 ¼ ½ 1 2 Miles



SOIL SURVEY MAP OF IROQUOIS COUNTY

UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION



LEGEND

900 Early Wisconsin Moraines
1000 Late Wisconsin Moraines
1100 Early Wisconsin Intermorainal Areas
1200 Late Wisconsin Intermorainal Areas

(a) UPLAND PRAIRIE SOILS

- 26 Brown silt loam
- 20 Black clay loam
- 60 Brown sandy loam
- 81 Dune sand
- 28 / 1128 Brown-gray silt loam on tight clay
- 28 / 1128 Brown silt loam on tight clay

(b) UPLAND TIMBER SOILS

- 34 Yellow-gray silt loam
- 64 Yellow-gray sandy loam
- 35 Yellow silt loam
- 38 Yellow-gray silt loam on tight clay

(c) 1500 TERRACE SOILS

- 1560 Brown sandy loam
- 1526 Brown silt loam
- 27 / 1527 Brown silt loam over gravel
- 1564 Yellow-gray sandy loam
- 81 / 1581 Dune sand
- 2 / 1534 Yellow-gray silt loam
- 36 / 1536 Yellow-gray silt loam over gravel
- 66 / 1566 Brown sandy loam over gravel
- 67 / 1567 Yellow-gray sandy loam over gravel
- 264 / 1526.4 Brown silt loam on gravel
- 1520 Black clay loam

(d) 1400 SWAMP AND BOTTOM LAND SOILS

- 1426 Deep brown silt loam
- 1454 Mixed loam
- 61 / 1461 Black sandy loam
- 10.2 / 1410.2 Peaty loam on sand
- 01 / 1401 Deep peat
- 02 / 1402 Medium peat on clay
- 1413 Clayey muck

Scale
0 ¼ ½ 1 2 Miles

SOIL SURVEY MAP OF IROQUOIS COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION